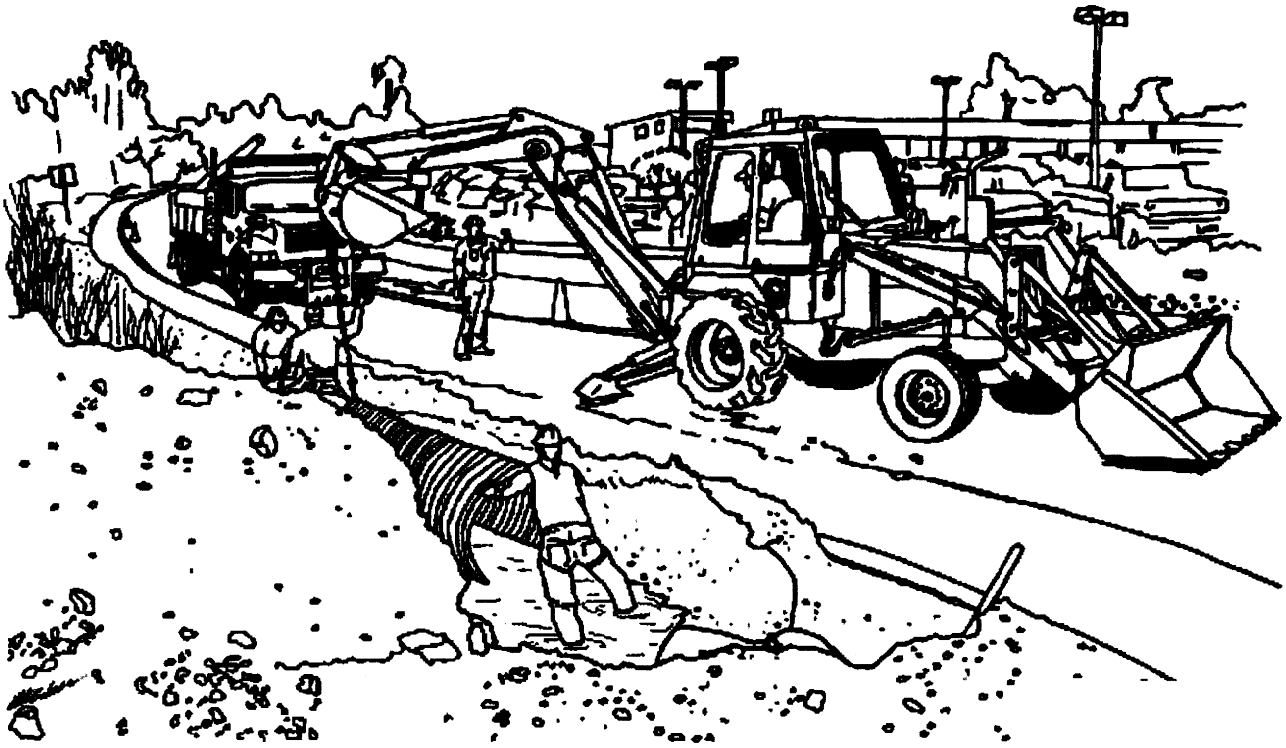
CITY OF BALTIMORE
DEPARTMENT OF PUBLIC WORKS

Specifications

Materials, Highways, Bridges, Utilities, and Incidental Structures

2006



Stephanie Rawlings-Blake, Mayor
City of Baltimore

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PROCUREMENT AND CONTRACTING REQUIREMENTS

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00 21 13.01 PURCHASE OF CONTRACT DOCUMENTS

Drawings, Contract Book (including Specifications) and other Contract Documents, if any, may be obtained at the location listed in the Notice of Letting between the hours of 9:00 A.M. and 4:00 P.M., except Saturdays, Sundays and holidays. The Contract Documents may be obtained on or after the time and date stated in the Notice of Letting, and upon payment of the amount stated in the Notice of Letting, in the form of a check payable to the Director of Finance. Checks for such Drawings, Specifications and Contract Documents shall be considered payment in full for the use of said Drawings, Specifications and Contract Documents. Payment will not be refunded.

00 21 13.02 LOCATION OF WORK

Work under the Contract will be restricted to the location or site specified in the Contract Documents. There shall be no deviation from the location so specified either by additions, subtractions or alterations by the Contractor or its representative without advance, written permission from the Engineer.

00 21 13.04 CONTRACT BOOK

The successful Bidder, upon execution of the Agreement and Bonds, will receive up to five (5) copies of the Contract Documents – no charge.

00 21 13.05 FAMILIARITY WITH PROPOSED WORK

The Bidder is required to examine carefully the site of the Work, the Bid, Plans, Specifications and other Contract Documents for the Work contemplated so as to fully familiarize and satisfy itself as to the conditions and obstacles to be encountered, the character, quality and quantities of Work to be performed and materials to be furnished in accordance with and/or reasonably inferable from the Contract Documents as being necessary to produce the intended results. As requirements of these Specifications, Plans, and other Contract Documents, it must be prepared to execute a finished job in every aspect without any extra payment, except as may be specifically provided for elsewhere in the Contract Documents. The Bidder shall examine the Contract Documents and shall verify all dimensions and job conditions relating to the Work, making certain that the same are satisfactory to produce first class Work as intended in the Contract Documents. Submission of a bid shall constitute an acknowledgement by the Bidder that he has received and completely reviewed all Contract Documents, including but not limited to addenda, and that the Contract Documents are sufficient and complete for purposes of allowing Bidder to timely and fully complete the Work with the time specified in the Contract Documents.

00 21 13.06 FAMILIARITY WITH LAWS

The Bidder is assumed to have made itself familiar with, and shall at all times comply with, all federal, state, local and municipal laws, ordinances, rules and regulations which in any manner affect those engaged or employed in the Work, or the materials or equipment used in or upon the Work, or in any way may affect the Work, whether or not provided for in the Contract Documents and without additional charge to the City, and no plea for relief of any sort shall be considered or justified due to ignorance and/or misunderstanding thereof. If the Bidder or Contractor shall discover any provision in the Plans, Specifications or Contract Documents that is contrary to or inconsistent with any such law, ordinance, rule, or regulation, and/or if the Bidder finds or believes there exists any ambiguity, discrepancy, error or omissions in the Contract Documents or the site conditions, it shall immediately report it to the Engineer in writing prior to proceeding with any Work that may be affected. Failure to report this matter by the Bidder shall constitute a full and complete waiver and release of any and all costs, time or other claim or dispute arising out of or relating to that unreported matter.

00 21 13.07 CONTENTS OF BID FORMS

The Bidder will be furnished Bid forms by the City, which will state the general location and description and the Work to be constructed and performed under lump sum and/or unit prices, the time in which the Work must be completed, the amount of the Bid Guarantee, (which must accompany the Bid), and any other pertinent information.

00 21 13.08 INSTRUCTIONS FOR FILLING IN BID FORMS

A. The Bidder shall submit its Bid in duplicate on the forms furnished by the City. The blank spaces in the Bid shall be filled in correctly where indicated, for each and every item, and the Bidder shall state the prices (written in ink, in words and numerals), for which it proposes to do each item of the Work contemplated. In case of discrepancy between the written figures and the numerals, the written figures shall govern.

B. All extensions in the bidding forms (column entitled "Amounts") shall be computed and filled in by the Bidder, and the sum shall be computed and written in the space provided thereto following the last item of the Bid.

C. All papers bound with or attached to the "original" Bid forms are necessary parts thereof and must not be detached. The Bidder shall also submit a "duplicate copy" of the Bid form, which is separate from the Specifications and is intended for information and reference purposes only. No information other than that included in or attached to the original Bid (where such attachment is permitted) will be used in determining award. Duplicate bid is for reference only.

D. When there is an error in mathematics where unit prices do not equal the total price, in all cases, the unit prices shall prevail.

E. Bids shall be submitted for the entire Contract as specified and/or shown.

00 21 13.09 INTERPRETATIONS BY ADDENDUM

A. If any person contemplating submitting a Bid or a Contract is in doubt as to the meaning of the Drawings, Specifications or other Contract Documents or any part thereof, he shall submit to the Engineer a written request for an interpretation thereof, provided said request is received by the Engineer on or before ten (10) days prior to the day on which the Bids are scheduled to be opened. All such requests for information shall be made in writing and the person submitting the request shall be responsible for its prompt delivery.

B. Any interpretation of the Contract Documents, if made, will be made only by written Addendum duly issued. A copy of such Addendum will be mailed or delivered to each person receiving a set of such documents. The Bidder must acknowledge all addenda so issued on its bid form. The City will not be responsible for any other explanations or interpretations of the proposed Contract Documents however made or given prior to the award of the Contract.

C. The City has made reasonable effort to assure each set of plans and Specifications is complete and accurate and contains all pages and drawings. Under circumstances where a Bidder receives a book or set of drawings in which pages have inadvertently been omitted and it is evident to a reasonable person upon observing the table of contents or the sequence of page numbers that such omission has occurred, it is requested the Bidder notify the City promptly. The Bidder/Contractor shall take no advantage of any omission. Bidder should be aware that subsequent to award of the Contract, the Engineer will issue no change orders based on omitted pages to Drawings or Specifications that were capable of discovery by Bidders, upon reasonable examination of the table of contents and surrounding circumstances.

00 21 13.10 SIGNATURES ON BIDS

A. Each Bid shall be properly executed. If the Bidder is an individual, the Bid must be executed by the Bidder with his/her name in full, followed by its printed name and title, if any, and its complete post office address. If the Bidder is a company, the Bid must be executed by an authorized official of the Bidder with its name in full, followed by his/her printed name and title, and the full and complete post office address of the company.

B. If the Bidder is a corporation, the Bid shall be executed by a person so authorized under the by-laws of the corporation. The printed name and title of the person executing the Bid must also be shown. A corporate bid must be attested to by the corporate secretary and the corporate seal must be affixed thereto. The full corporate post office address must be given. The state of incorporation must appear on the Bid. Anyone executing a Bid as an agent of the corporation shall file with the bid, legal evidence of its authority to do so.

C. If the Bidder is a joint venture comprised of two (2) corporations, each joint venture shall follow the directions in Section B of this clause.

D. The address supplied under this clause shall be deemed the official address of the Bidder for any and all correspondence sent from the City, unless a different address is requested in writing by the bidder.

00 21 13.11 IRREGULAR BIDS

Bids may be rejected if they show any omissions; alterations of form, character, quality and/or quality not called for; conditional or alternate Bids not called for; or irregularities of any kind. The City reserves the right to reject any nonconforming, non-responsive, unbalanced, or conditional proposals unless expressly required or authorized in the Bid documents.

00 21 13.12 BID SECURITY (CHECK OR BID BOND)

A. Each Bid shall be accompanied by a certified check from the Bidder, or a bank cashier's check, or a bank treasurer's check upon a solvent clearing house bank or a Bid Bond executed on the form as provided in the Bid documents, for an amount which is not less than that determined by multiplying the total Bid submitted by two percent (2%), and made payable to the director of finance. The check or bid bond shall be forfeited to the City as liquidated damages, which is not intended nor should be construed as a penalty, in case an award is made and the Contract, required Bonds, insurance certificates and other submission requirements set forth in the Contract Documents are not promptly and properly executed and returned within ten (10) business days after award. The City may annul the Notice of Award without liability to Bidder; whereupon, the Bidder's proposal security shall be forfeited to the City. The Contractor shall also return with the executed Contract and Bond, any and all insurance policies and certificates required or called for in the Contract Documents.

B. The checks of the unsuccessful Bidders will be returned and the Bid Bond voided after the Contract is awarded, and the check of the successful Bidder will be returned to it and its Bid Bond voided after the proper execution and return of the required Contract Bonds, insurance certificates, and other required documents.

C. Surety Bonds may only be submitted from Surety companies authorized to transact business in the State of Maryland and listed as an approved surety for projects in excess of the Bid and/or Contract amount on the U.S. Treasury's Circular 570, list of approved sureties, at the time of Bid submission and/or Contract execution, as the case may be.

00 21 13.13 DELIVERY OF BIDS

A. All Bids will be irrevocable when filed with the Comptroller of Baltimore City. All Bids shall be submitted in duplicate on the Bid forms to be obtained from the Contracting Agency. All information required by the form shall be given, and all spaces filled in. In case of discrepancy between the written figures and numerals, the written figures shall govern. The Board of Estimates reserves the right to reject any Bid not in compliance with the above.

B. Fill out form of Bid marked "Original Not To Be Detached" bound in the Contract Documents, and leave it bound therein.

C. Enclose and seal the Contract Documents (in which the Original Bid is bound), the detached "Duplicate" copy of the Bid and bid security in the required amount, in the envelope provided by the contracting agency. The blank spaces on the envelope shall be filled in correctly so as to indicate its contents clearly.

D. Deliver the Bid as specified in the Notice of Letting. If forwarded by mail, the above-mentioned envelope shall be placed in another envelope, addressed to the "Comptroller, Room 204, City Hall, Baltimore, Maryland 21202", preferably by registered mail. If forwarded otherwise than by mail, it shall be delivered at the Office of the Comptroller. Bids will be received until the time and date set in the Notice of Letting.

E. For contracts in which the Special Provisions are in multiple volumes, the Bidder is advised that it must include the complete (original) Contract Book Volume I only and duplicate of Bid in the Bid envelope at the time it submits its Bid to the Office of the Comptroller.

F. Modifications of Bids shall not be considered.

00 21 13.15 OPENING OF BIDS

Bids will be publicly opened by the Board of Estimates at the time and date set in the Notice of Letting in City Hall, Baltimore, Maryland. Bidders or their authorized agents are invited to be present.

00 21 13.16 ESTIMATED QUANTITIES

A. The Bidder's attention is called to the fact that any quantities given in the "Bid" are approximate only and are intended to be a guide to the Bidder. However, such quantities in no way bind or limit the City as to the actual amount of Work to be performed, or the quantity of material to be furnished.

B. Any estimates of quantities herein furnished by the Engineer are approximate only, and have been used by the Engineer as a basis for estimating the cost of Work, and will also be used for the purpose of tabulating and comparing the Bids and awarding the Contract. The Engineer has endeavored to estimate these quantities correctly according to the Engineer's knowledge and the information as shown on the Plans, but it is not guaranteed that these estimated quantities are accurate, and, consequently, if the Contractor, in making up and/or submitting its Bid(s) relies upon the accuracy of said estimated quantities, it does so at its own risk.

C. The Bid may contain certain contingent items, which have been included merely for the purpose of obtaining a Contract Price in case these items may be needed.

D. Variation in estimated quantities: Where the quantity of a pay item in a Contract is an estimated quantity and where the actual quantity of such pay items varies more than twenty-five percent (25%) above or below the estimated quantity stated in the Contract, an equitable adjustment in the Contract Price shall be made after receipt of written demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above one hundred twenty-five percent (125%) or below seventy-five percent (75%) of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the Contractor shall so notify the City, and/or its authorized representative, pursuant to Section 01 32 16, DD, Request for Time Extension, in writing within ten (10) days from the beginning of the delay, otherwise any such time extension shall be deemed to have permanently and irrevocably been

waived. The City shall ascertain the facts and make the adjustment for extending the completion date as in its judgment the findings justify.

00 21 13.17 BID AND PAYMENT FOR WORK

A. Unit prices: The Contractor shall Bid and accept a "unit price" for each of the unit price items in the Bid. The price per unit shall be multiplied by the estimated quantity for each item to tabulate the total estimated price for these items. This total price shall be added to the "lump sum" price items in the Bid to arrive at a Bid total for comparison of Bids and award of Contract.

B. Lump Sum Prices: The Contractor shall Bid and accept a "lump sum" price for each of the "lump sum" items in the Bid. "Lump sum" prices constitute full payment for all Work called for under these items. Any alterations in the Plans and/or Specifications included in such "lump sum" prices which cause increased cost, or results in decreased cost to the Contractor, shall be paid for by the City, or credited to the City, in accordance with 01 26 10.

00 21 13.18 TAXES – RESPONSIBILITY FOR PAYMENT AND EXEMPTIONS

A. The Contractor is responsible for and, by submitting a Bid, agrees to pay all retail sales tax, income tax, real estate tax, use tax, transportation tax, special taxes and any other taxes applicable to and assessable against any labor, materials, equipment, processes, and/or operations incident to or involved in the Work. The Contractor is responsible for ascertaining and acquainting itself with such taxes and making all necessary arrangements to pay same.

B. Contractors and Subcontractors should include the Maryland Sales and Use Taxes on all purchases. The Contractor will be required to pay the taxes on all purchases and can recover it only as part of its Bid.

00 21 13.19 COLLUSION AMONG BIDDERS

A. An affidavit certifying anti-collusion activities of the Contractor is included with the Bid form and made a part thereof.

B. The Contractor agrees that any violation of any of the representations contained in the foregoing affidavit shall constitute a breach of said Contract, and the City's remedies for any such breach as provided in the Contract Documents shall be in addition to and not in lieu of any other remedies or penalties provided or allowed by law or equity.

00 21 13.20 PRE-QUALIFICATION OF CONTRACTORS AND SUBCONTRACTORS

A. All Contractors and Subcontractors desiring to Bid on, or subcontract for, work for this Standard (Bid) under the jurisdiction of the City of Baltimore and whose Bid or Contract amount will be twenty-five thousand dollars ($25,000.00) or more, will be required to be pre-qualified for work categories involved. All Contractors bidding on this standard must first be pre-qualified by the City of Baltimore Contractors Qualification Committee.

B. The attention of the Contractor is directed to the following:

1. Subcontractors do not have to be pre-qualified at the date Bids are submitted.
2. Subcontractors must, however, be pre-qualified by the City before the Subcontractor can begin work on the project.
3. The Department of Public Works will assist the Subcontractors whenever possible in the pre-qualification procedure.

C. Only the Bids of Contractors who hold a pre-qualification certificate at the time of Bid opening will be considered.

D. All applicants for pre-qualification are required to submit:

1. A Contractor's application,
2. A Contractor's financial statement, under oath,
3. An experience questionnaire, and
4. An affirmative action plan.
5. Any other forms as required from time to time.

These forms will be furnished by the Contractor's Qualification Committee upon request. They must be filed with the executive secretary of the committee, not less than thirty (30) days prior to the opening date specified in the Bid. Pre-qualification will be based on the information supplied by the Contractor on the documents listed above.

E. A qualified Contractor is one whose financial rating and classification has been determined by the Contractor's Qualification Committee, and ratified and confirmed by the Board of Estimates.

F. A prospective Bidder shall, when pre-qualifying, state in its application the extent and type of Work it considers itself qualified to handle at one (1) time. Its experience questionnaire shall show the exact type of Work it has performed during the preceding five (5) years. Its certified financial statements shall provide a detailed and current summary of its financial position during the preceding five (5) calendar years together with a certification of its bonding capacity and rate charged by its Surety (identity of Surety also to be disclosed), its current worker's compensation experience modifier, and the identity of its current general liability insurance carrier(s) together with its limits of coverage and deductibles for each policy. This information shall be the basis for a determination of its financial rating, stability and its Work classification. Following these determinations, the Contractor will receive a certification of pre-qualification by registered or certified mail from the executive secretary of the committee.

G. A Contractor may, upon request, receive an analysis of its rating.

H. A Contractor dissatisfied with this rating or classification, or both, may request reconsideration by the Board of Estimates if made, in writing, within seven (7) days after receipt of a tentative or provisional rating.

I. A Bidder who is qualified shall also furnish additional information bearing on its qualifications, as may be required by the committee, the Engineer, and/or the Board of Estimates of the City.

J. The Board of Estimates reserves the right to reject the Bid of any Bidder who fails to furnish, promptly and properly, all the information called for, when notified to do so.

K. Each Bidder shall further qualify, as otherwise called for, in the Contract Documents.

L. A prospective Bidder may purchase plans if its pre-qualification forms have been submitted at least thirty (30) days prior to the opening date specified on the Bid. Material suppliers and other interested parties may obtain plans without filing a pre-qualification application. The plans may be marked "Not for Bidding purposes".

00 21 13.21 PROJECT COST CLASSIFICATION SCHEDULE

The City will estimate the cost of the Contract and publish in the Notice of Letting one of the following cost groups:

$	25,000.00	to	$ 100,000
$	100,000.01	to	$ 500,000
$	500,000.01	to	$ 1,000,000
$	1,000,000.01	to	$ 2,000,000
$	2,000,000.01	to	$ 3,000,000
$	3,000,000.01	to	$ 4,000,000
$	4,000,000.01	to	$ 5,000,000
$	5,000,000.01	to	$ 10,000,000
$	10,000,000.01	to	$ 15,000,000
$	15,000,000.01	to	$ 20,000,000
$	20,000,000.01	to	$ 30,000,000
$	30,000,000.01	to	$ 40,000,000
$	40,000,000.01	to	$ 50,000,000
$	50,000,000.01	to	$ 60,000,000
$	60,000,000.01	to	$ 70,000,000
$	70,000,000.01	to	$ 80,000,000
$	80,000,000.01	to	$ 90,000,000
$	90,000,000.01	to	$100,000,000
$100,000,000.01			$125,000,000
$125,000,000.01			$150,000,000
Over $150,000,000			

00 22 13 SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

00 22 13.01 INDEMNIFICATION

To the fullest extent permitted by law, the Contractor shall indemnify, defend and hold harmless the City and its elected and appointed officials, departments, agencies, employees, agents, design professionals, project Inspectors, separate Contractors and consultants, and all other representatives together with all officers, directors, employees, agents and representatives of any of them (hereinafter collectively referred to as the "indemnified parties") from and against any and all claims, demands, suits, causes of action, expenses or other liability of whatsoever kind or nature, whether in Contract or tort, and by whomsoever brought, including without limitation reasonable attorney fees, fees for outside consultants, Contractors and experts, and court costs, threatened or brought

against any of the indemnified parties arising out of or relating to, or alleged to arise out of or relate to, any direct or indirect act or omission of the Contractor and its officers, directors, employees, agents, Subcontractors, suppliers and other representatives for which it is responsible by Contract or by law except to the extent actually caused by the sole negligence and/or intentional wrongdoing of one or more of the indemnified parties hereunder. Contractor's obligations under this section, 00 22 13.01, shall not be limited or defined in manner whatsoever by the amount of insurance required by the Contract Documents or by any limitations or restrictions on the amount or type damages, compensation or benefits to, by, or for the Contractor under any applicable worker's compensation acts, disability acts or any other laws related to employee benefits. The rights of the indemnified parties under this 00 22 13.01 shall not be diminished, waived, discharged or released, in whole or in part, by the exercise of any other remedy allowed by law or other provisions of the Contract Documents. Contractor's obligations hereunder shall survive final completion, final payment, and any termination of the Contract.

00 22 13.02 LEGAL ADDRESS

A. The address given in the Bid is hereby designated as the legal address of the Contractor. Such address may be changed at any time upon delivery of written notice to the Engineer. The delivery at such legal address or the depositing in any post office, in a postpaid, registered wrapper directed to the above mentioned address of any notice, letter or other communication to the Contractor, shall be deemed to be a legal and sufficient service thereof upon the Contractor.

B. The delivering to or the mailing to, the Contractor's business address (written notice of which address shall be given to the Engineer), or the delivering to the Contractor in person or to its authorized representative, of any notice, letter or other communication shall also be deemed to be a legal and sufficient service thereof upon the Contractor.

DIVISION 00 23 00 DEFINITIONS & EQUIVALENTS

00 23 00.01 DEFINITIONS OF CITY TERMS

Whenever the following appear in Standards, Bids, Agreements, Contracts, Bonds and/or other Contract Documents, the intent and meaning shall be interpreted as follows:

ADDENDUM	Written or graphic instrument issued prior to the opening of bids, which clarifies, corrects, or changes, the bidding or Contract Documents.
ADDITIONAL WORK	Increase in quantities of Work above those shown in the Contract Documents.
ADVERTISEMENT	The public announcement, as required by law, inviting Bids for Work to be performed or materials to be furnished.
AGREEMENT	The settlement or pact between the Contractor and the City which is a document forming a part of the Contract.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS	Whenever the name American Association of State Highway Officials (AASHO) appears it should be construed to be American Association of State Highway and Transportation Officials (AASHTO).
APPRENTICE	(1) A person employed and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Bureau of Apprenticeship Training, or with a State apprenticeship agency recognized by the Bureau; (2) A person in his/her first ninety (90) day probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been Certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Council (where appropriate) to be eligible for probationary employment as an apprentice.
AS BUILT	Set of plans created to match the actual construction, which may differ from the original design documents.
AS IS	Existing condition upon start of any Project.
AWARD	The decision of the City to accept the Bid of the lowest responsive and responsible Bidder for the Work, subject to the execution and approval of a satisfactory Contract, Bonds to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.
BARRICADE-TYPE II	A barricade that is thirty-six inches (36″) high with flashing lights separating Work zone from vehicle traffic.
BASE COURSE	The layer or layers of specified selected material of designed thickness placed on a subbase or a subgrade to support a surface course.
BID	The approved prepared form on which the Bidder submits, or has submitted, its proposal for the Work contemplated.
BIDDER	Any individual, firm or corporation that has been pre-qualified pursuant to the Charter by the City and submits a Bid for the Work contemplated, acting directly or through a duly authorized representative.
BID BOND	The security in the form approved by the City and executed by the Bidder and its Surety and paid for by the Bidder. The Bid Bond, when required, shall be in the amount designated by the City as a guarantee on the part of the Bidder to enter into a Contract with the City, if the Work of constructing the improvement is awarded to the Bidder.

BID FORM	The approved form on which the City requires bids to be set forth and submitted.
BID GUARANTEE	Certified check, bank cashier's check, bank treasury check drawn upon a clearing house bank or Bidder's Surety Bond accompanying the Bid as a guarantee that the Bidder will enter into a contract with the City for the performance of the Work.
BID ITEM	An item of Work specifically described and for which a price, either unit or lump sum, is quoted by the Contractor. It includes the performance of all Work and the furnishing of all labor, equipment and materials described herein or described in any Supplemental Standards or Special Provisions.
BOARD OF ESTIMATES	Mayor, Comptroller, City Solicitor, President of the City Council and Director of Public Works.
BOND	Bid, performance, and payment bond or other instrument of security.
BRIDGES	The word "bridges" shall mean any bridge or highway grade separation structure and shall embrace the sub-structure and superstructure and the approaches thereto, and such entrance plazas, interchanges, overpasses, underpasses, connecting highways and other structures which the City may deem necessary in connection therewith, together with all property, rights, easements, franchises, and interest acquired by the City for the construction and operation of such bridge. For the convenience of and definition by the City, a bridge will also be known as a structure more than twenty feet (20') in length. The City's definition of length shall be the out to out dimension of the floor or from back wall to back wall of abutments. For arches, the length shall be the clear span. For box culverts and batteries of pipes, the length shall be out to out of outer walls and out to out of shells of outside pipes. For lengths, all dimensions shall be parallel to the centerline of the roadway. The dimensions of handrails will not be taken into account in measuring bridge lengths.
BUILDING PERMIT	A permit issued by appropriate governmental authority allowing construction of a project in accordance with approved Drawings and Specifications.
BUSINESS	A corporation, partnership, individual, sole proprietorship, joint venture, or any other legal entity through which commercial activity is conducted.

CALENDAR DAY	Every day shown on the calendar, Saturdays, Sundays and holidays included.
CERTIFICATE OF OCCUPANCY	Document issued by governmental authority certifying that all or a designated portion of a building complies with the provisions of applicable statutes and regulations, and permitting occupancy for its designated use.
CHANGE ORDER	A written authorization to the Contractor duly signed by the Engineer on behalf of the City ordering a change in Work that has been found necessary and is not included in the original Plans and Specifications. Subject to other provisions of the Contract Documents, if the Work is of a nature involving an adjustment of price or time, a Change Order to the Contract shall be executed with final approval payment by the City.
CHANNEL	A natural or artificial watercourse.
CHARTER	The Baltimore City Charter and any and all subsequent amendments and additions thereto which may thereafter be ordered.
CITY	Mayor and City Council of Baltimore, a municipal corporation and body politic of the State of Maryland, commonly referred to as Baltimore City.
COMAR	Code of Maryland Regulations.
CONDITIONAL ACCEPTANCE	The certified acceptance of the Contract Work (CA) by construction management when the Work is essentially complete and the one (1) year warranty or maintenance period begins.
CONSTRUCTION	The process of building, adding, altering, converting, relocating, renovating, replacing, or restoring of real property in which the City has an interest.
CONSTRUCTION STRIP	An area adjacent to the right-of-way or easement temporarily acquired for the use of the Contractor during the execution of the Work. This area is shown on the Plans for interpretation and clarification of the Plans.
CONTRACT	All terms, conditions, items and information contained in the Specifications, Plans, Bid Documents, Agreements, Change Orders, Amendments and Bonds and therein referred to, are to be considered as one instrument forming the Contract. This includes any and all supplemental agreements, which could reasonably be required to complete the entire Work contemplated.

CONTRACT BONDS	The approved forms of security, executed by the Contractor and its Surety or Sureties, guaranteeing complete and full execution and performance of the Contract and all supplemental agreements pertaining thereto, and payment to all employees, subcontractors, suppliers, and other parties to which payments are owed arising out of or relating to the Work. Contract Bond shall also mean the same as Performance Bond and Payment Bonds.
CONTRACT DOCUMENTS/ CONTRACT	The written agreement executed between the City and the successful Bidder, covering the performance of the Work and furnishing of labor, equipment and materials, by which the Contractor is bound to perform the Work and furnish the labor, equipment and materials, and by which the City is obligated to compensate it therefore. The Contract shall include the Invitation for Bids, Notice to Contractors, Instructions to Bidders, Bid, Contract Forms and Bonds, General Provisions, Technical Specifications, Standard Details, all special provisions, all technical provisions, all Plans, Addenda, and Notice to Proceed, also any written Change Orders and supplemental agreements that are required to complete the construction of the Work in an acceptable manner including authorized extension thereof. This includes the Green Book, the drawings, the book of standards and the project manual.
CONTRACT DRAWINGS	See definition of "Plans".
CONTRACT ITEM (Pay Item)	An item of Work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all Work and the furnishing of all labor, equipment and materials, described herein or described in any Supplemental Specifications or Special Provisions.
CONTRACT MODIFICATION	Any written alteration to the Specifications, delivery point, date of delivery, contract period, price, quantity, or other provision of any existing Contract, whether accomplished in accordance with a contract provision, or by mutual action of the parties to the Contract. It includes change orders, extra Work orders, supplemental agreements, Contract amendments, reinstatements, or options/renewals.
CONTRACT PRICE	Total amount of money for which the Contract is awarded.
CONTRACT UNIT PRICE	The amount stated in the Bid for a single unit of an item of Work.
CONTRACT TIME OR COMPLETION DATE	The number of calendar days shown in the Bid and Notice of Letting indicating the time allowed for the completion of the Work contemplated in the Contract. In case a calendar date of completion is shown in the Bid, in lieu of

	the number of calendar days, such Work shall be completed by that date.
CONTRACTOR	The party entering into the Contract for the performance of the Work required thereby, and the legal representative of said party or agent, appointed to act for said party in the performance of the Work.
CONTROLLED ACCESS ARTERIAL HIGHWAY	The term "controlled access arterial highway" shall mean a major thoroughfare of two (2) or more traffic lanes in each direction having the same characteristics as an expressway except that the conflict of cross-streams of traffic need not be eliminated at every intersection by means of grade separation structures.
CONTROLLING OPERATION	An operation of either major or minor proportions, which at the particular time under consideration has a controlling effect on the progress of the Project as a whole.
CULVERT	Any structure not classified as a bridge, which provides an opening under any roadway.
DATE OF SUBSTANTIAL COMPLETION	The date certified by the Designer or Engineer when the Work or a designated portion thereof is sufficiently complete in substantial accordance with the Contract Documents so that the City may occupy.
DAY	Calendar day unless otherwise designated.
DESIGNER	The City or private entity who developed the Contract Plans and Specifications.
DEVELOPER	An individual, partnership, corporation, or other non-City entity that, under agreement(s), constructs public improvements that is to be incorporated into the City's systems.
DIRECTOR	The Head of either the Department of Transportation, the Department of Public Works or the Department of Recreation and Parks.
DOMESTIC MANUFACTURE	When referring to metallic items such as structural steel, pipe, reinforcement, bridge rails, etc., the term "Domestic Manufacture" is intended to mean those metals whose final alloying has taken place within the United States.
DRAINAGE DITCH	In general, any open watercourse other than gutters, constructed beyond the limits of cut or fill slopes for excavation or embankment, as indicated by the typical section shown on the Plans.

DRAINS, SEWERS	The term "Drain" or "Sewer" or any pronouns used in their place, wherever they occur in these Standards, shall mean any storm water drain or sanitary sewer.
DRAWINGS	All drawings, profiles, cross sections, working drawings and supplemental drawings, or reproductions thereof, pertaining to the Work, approved by the Engineer, which show the location, character, dimensions or details of Work.
EASEMENT (Right-of-Way)	A grant of a right-of-use of the property of an owner for a certain purpose at the will of the grantee.
ENGINEER	The duly authorized representative of the City of Baltimore.
ENVIRONMENTAL POLLUTION	Defined as the presence of chemical, physical or biological elements or agents, which adversely affect human health or welfare; affect other species of importance to humans, or degrade the utility of the environment for aesthetic and recreational purposes. The control of environmental pollution requires consideration of air, water and land and involves noise and solid waste management, as well as other pollutants.
EQUIPMENT	All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the Work.
EXPENDITURE AUTHORIZATION REQUEST (EAR)	The formal funding mechanism for capital expenditure including change orders approved by the Board.
EXPRESSWAY	The term "expressway" shall mean a major thoroughfare of two (2) or more traffic lanes in each direction, designed to eliminate principal traffic hazards, and shall embrace all bridges, tunnels, overpasses, underpasses, interchanges, entrance plazas, approaches, and other structures, which the City may deem necessary to the operation of the expressway, together with all property, rights, easements, franchises and interests acquired by the City for the construction and operation thereof, and having the following characteristics: (a) a median divider separating opposing traffic lanes to eliminate head-on-collisions and sideswiping; (b) grade separating structures to eliminate the conflict of cross-streams of traffic at all intersections; (c) points of access and egress limited to predetermined locations; (d) vertical curves of lengths sufficient to provide long sight distances; and (e) shoulders of widths adequate to permit vehicles to stop or park off traffic lanes.
EXTRA WORK	Work which was not provided for in the original Contract.

EXTRA WORK ORDER	A written directive covering Extra Work, the performance of said Extra Work. Such Work may be performed at agreed prices or on a force account basis as provided elsewhere herein.
FEDERAL AGENCIES	Whenever, in these Standards, reference is made to any federal agency or officer, such reference shall be deemed made to any agency or officer succeeding in accordance with the law to the powers, duties, jurisdiction, and authority of the agency or officer mentioned.
FINAL ACCEPTANCE	The acceptance of Contract Work by the City after it has verified that the equipment and systems are fully operational, all warranty work is complete and the Contractor has fulfilled its Contract obligations.
FINAL QUANTITY BOOK	Quantities confirmed by the Engineer, based on Inspection documents, used to close-out jobs, prior to final payment.
FIXED-PRICE CONTINGENT ITEMS	These unit prices are established and prescribed to compensate for the cost of Work and materials that may or may not be necessary for the proper completion of the Contract, and the quantities of which are not amenable to reliable quantitative estimating prior to the construction. The fixed-price items are shown on the Bid with the estimated quantities, fixed-price, and the estimated total cost imprinted prior to the issuance of the Contract Documents to Bidders.
FORCE ACCOUNT	Extra Work due to unforeseen conditions, which is documented and paid based on time and material method.
GUARANTEE	An assurance that roadways, utilities, structures, plants, shrubbery, etc. will not fail within a time frame as specified in the Contract Documents.
GUTTER (Pertaining to Roads)	Any prepared open watercourse, whether paved or not, constructed inside of the shoulder line in embankment or contiguous to both the shoulder line and the base of the cut slope in excavation sections. For the purpose of clarification of the above definition, a section shall be considered to be an embankment when the elevation of the extended shoulder slope is generally at or above the existing ground surface and shall be considered in excavation when the elevation of the shoulder line is below the existing ground surface.
INSPECTION	Examination of the Work completed or in progress to determine its compliance with the Contract Documents. The Engineer ordinarily makes inspections of a construction Project. The construction Inspector makes

	continuous inspections. Inspection is performed for the City's information and convenience only and does not relieve the Contractor of responsibility for quality or compliance with Contract Documents.
INSPECTOR	An authorized representative of the Engineer, assigned to make any or all necessary inspections of the Work performed and materials furnished by the Contractor.
INVITATION FOR BIDS	Any document, whether attached or incorporated by reference, used for soliciting bids under procurement by competitive sealed bidding and small procurement procedures including requests for quotations.
LABORATORY	Such testing laboratory as may be designated by the Engineer.
LIMIT OF DISTURBANCE	The area identified on construction documents within which the Contractor may operate.
MATERIALS	Any substances specified for use in the construction of the Project and its appurtenances.
MINOR STRUCTURE	Includes: catch basins, inlets, manholes, retaining walls, steps, fences and other miscellaneous items.
MUTCD	Manual on Uniform Traffic Control Devices.
NOTICE OF AWARD	The written notice by the Department to successful Bidder stating that upon compliance by it with certain required conditions, the Department will execute the Contract.
NOTICE OF LETTING	Public notice and legal advertising in newspapers announcing location and magnitude of the Work to be done and quantity of the material to be furnished and time and place of Bid acceptance and opening of Bids.
NOTICE TO PROCEED	A written notice by the City to the Contractor of the date on which it shall begin the prosecution of the Work to be done under this Contract.
OFFICIAL TIME OF BALTIMORE CITY	Official Time of Baltimore City shall mean that time as set forth by the Mayor and City Council of Baltimore.
OR EQUAL	Substitution allowed in the Contract, but must be approved in advance and in writing by the Engineer, and/or the contracting agency.
OWNER/OWNERS	Mayor and City Council of Baltimore.

PAYMENT BOND	The approved form of security, executed by the Contractor and its Surety or Sureties, guaranteeing payment to all persons supplying labor and/or materials to the Contractor and to any Subcontractor of the Contractor in the prosecution of the Contract and all Supplemental Agreements thereto. Payment Bond shall also mean the same as Labor and Material Bond.
PERMIT	Issued by appropriate governmental authority allowing construction of a project in accordance with approved Drawings and Specifications.
PLANS	The official approved plans, profiles, typical cross sections, Working Drawings and Supplemental Drawings, or exact reproduction thereof which show the location, character, dimension, and details of the Work to be done, and which are to be considered as a part of the Contract supplementary to these Specifications and which are identified as such.
PRIME COAT (AS IT PERTAINS TO ROADS)	An application of liquid bituminous material.
PROFILE GRADE	The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade also means either elevation or gradient of such trace according to the context.
PROGRESS PAYMENT	Partial payment made during the progress of the Project, based on Work completed and/or materials received and suitable stored at any given time period.
PROPOSAL	See "Bid".
PUBLIC UTILITIES	Utilities owned and maintained by the City, Verizon Telephone Company and the Baltimore Gas and Electric Company or their successors or assignees or any other utilities that may be present on or in the job site.
PUNCH LIST	The list of deficiencies identified during inspection for Conditional Acceptance of the Contract Work. The Contractor must resolve all the items noted in the Punch List before Conditional Acceptance is granted.
QUESTIONNAIRE	The approved form or forms upon which the Contractor shall furnish the information as to its ability to perform the Work, its experience in similar Work, the equipment to be used, and its financial condition as related to its ability to finance the Work.

RAILROAD GRADE SEPARATION	The term "railroad grade separation" shall mean any overpass or underpass which shall eliminate any railroad grade crossing, and shall embrace the overpass and underpass structure and the approaches thereto, and such entrance plazas, interchanges, connecting highways and other structures which the City may deem necessary in connection therewith, together with all property, rights, easements, franchises and interests acquired by the City for the construction and operation of such railroad grade separation.
RELEASE OF RETAINAGE	Full Retainage is released, at the City's sole discretion, upon Final Acceptance of the project. Partial release of retainage may occur prior to release of the final payment at the City's discretion.
REQUEST FOR INTERPRETATION (RFI)	Request for additional information and/or clarification of the Contract Documents by the Contractor, Design Consultant, or City.
RESPONSIBLE BIDDER OR OFFEROR	A person who has the capability in all respects to perform fully the Contract requirements, and the integrity and reliability which shall assure good faith performance.
RESPONSIVE BIDDER	A person who has submitted a Bid under procurement by competitive sealed bidding which conforms in all material respects to the requirements contained in the Invitation for Bids.
RETAINAGE	The sum withheld from progress payment. The Contract value of Work satisfactorily performed during the preceding calendar month will be paid to the Contractor, less 10%, subject to other provisions of the Contract Documents. When such ten percent (10%) retainage amounts to five percent (5%) of total Contract value, plus authorized extras and additions, no further retainage will be deducted from the monthly payments due the Contractor if the City, in its sole discretion, deems the Contractor's performance up to that point satisfactory. The five percent (5%) retainage will not be released until final payment (unless partially released in a semi-final payment). When the amount earned during any one (1) month period, less the appropriate retained percentage, shall be less than five hundred dollars ($500.00), no payment will be made except on the last current estimate, until the last preceding payment is at least five hundred dollars ($500.00).
RIGHT-OF-WAY	The area, which has been acquired and reserved by the City for use in constructing the proposed improvement and appurtenances thereto.

SEAL COAT (AS IT PERTAINS TO ROADS)	An application of liquid bituminous material followed by an application of cover coat aggregate.
SETBACK LINE	A line established by law, deed restriction or custom, fixing the minimum distance of the exterior face of buildings, walls and any other construction from a street or highway right-of-way line.
SLOPES (AS IT PERTAINS TO ROADS)	The graded area beyond the shoulder or curb and extending from the shoulders or curb to the natural undisturbed surface of the ground.
SPECIAL PROVISIONS	Special directions, provisions or requirements, peculiar to the Project under consideration and not otherwise thoroughly or satisfactorily detailed or set forth herein.
SPECIFICATIONS	The general term comprising all definitions, instructions, descriptions, directions, provisions and requirements, contained herein and all written supplements thereto, made or to be made, pertaining to the performance of the Work and the materials and workmanship to be furnished under the Contract.
STANDARDS	Detailed Standard Drawings prepared by the Department of Public Works or Transportation and such other Standards as may be referred to by the Engineer, the Contract Plans and/or the Specifications.
STANDARD SPECIFICATIONS	A book of Specifications intended for general application and repetitive use.
START UP	Start up of the project is only after Notice to Proceed; start up of a facility usually occurs after all individual system testing is completed.
STATE	The State of Maryland acting through its authorized representative(s).
STATE HIGHWAY SYSTEM	The term “State Highway System” means that system of roads which are from time to time owned by the State and which the State Highway Administration by resolution from time to time designates as State roads to be maintained and operated by the State.
STATE ROAD	The term “State Road” means any public road included in the State Highway System.
STREET	A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

STRUCTURES	Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing manholes, end walls, buildings, sewers, water mains, service pipes, under drains, foundation drains and other features which may be encountered in the Work and not otherwise classified.
SUBCONTRACTOR	An individual, firm or corporation that contracts with a Contractor to perform part of the latter's Contract.
SUBGRADE	The material in excavations (cuts), embankments (fills), and/or foundations immediately below the first layer of sub-base, base or pavement or bottom of pipe, foundations, or other structure, and to such depth as may affect the structural design.
SUBGRADE FOR ROADWAY	The material in excavation (cuts) and/or embankment (fills) upon which is placed the first layer of sub-base, base, stabilization, or pavement.
SUBGRADE FOR SANITARY SEWERS, STORM WATER DRAINS AND WATER MAINS	The subgrade for Sewers and Drains refered to is described as follows: (1) For masonry drains, it is the lowest outside surface of the bottom of the masonry foundation. (2) For pipes without concrete encasement, it is the lowest point of the underside of the invert of the pipe. (3) For pipes encased in concrete, it is the lowest surface of the bottom of the concrete. (4) For pipes and inlet connections on concrete cradle, it is the lowest outside surface of the bottom of the concrete cradle.
SUBSTRUCTURE	All of that part of the structure below bottoms of bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the back walls and wing walls.
SUPERSTRUCTURE	All of that part of the structure above bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, except as noted above for the substructure.
SUPERINTENDENT	The executive representative of the Contractor authorized to receive and execute instructions from the Engineer, and who shall supervise and direct the construction.
SUPPLEMENTAL SPECIFICATIONS	Additions and revisions to the Standard Specifications, generally includes new or improved procedures, construction items or materials developed subsequent to the publication of Standard Specifications or precise Specifications for an individual contract.

SURETY	A firm or corporation executing a Surety Bond, or Bonds, payable to the City, securing the performance of the Contract, either in whole or in part; or securing payments for labor and materials.
SURFACE TREATMENT	As it pertains to roads; the application of one (1) or more seal coats with or without a prime coat.
TITLES (OR HEADINGS)	The titles or headings of the sections and articles intended for convenience of reference and shall not be considered as having any bearing on their interpretation.
TRAFFIC LANE	The portion of a traveled way for the movement of a single line of vehicles.
TRAINEE	A person receiving on-the-job training in a construction occupation under a program which is approved (but not necessarily sponsored) by the U.S. Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training and which is reviewed from time to time by the Manpower Administration to insure that the training meets adequate standards.
TREE PROTECTION EXPERT	Baltimore City Staff person authorized to enforce the rules and regulations found in Article 7, Division IV, City Code, Forest and Tree Protection, or any amendment thereafter.
TRENCH	An excavation made for the purpose of installing or removing pipes, drains, catch basins, etc., and which is later refilled.
UTILITIES	The term shall mean storm drains, sanitary sewers, water mains, gas mains, electric and telephone lines, television cables, and traffic signal conduits and their appurtenances.
VALUE ENGINEERING	A specialized cost control technique, which utilizes a systematic and creative analysis of the functions of a project or operation to determine how best to achieve the necessary function, performance, and reliability at the minimum life cycle cost.
VENDOR	A supplier of goods and/or materials.
WARRANTY	An assurance that installed equipment will operate or perform as described by the manufacturer or supplier, within a time frame, as specified in the Contract Documents.
WORK	Any or all things agreed to be furnished or done by or on the part of the Contractor and which are required in the

	construction and completion of the project herein contemplated, including labor, materials, tools and/or equipment.
WORKING DRAWINGS	Stress sheets, shop drawings, fabrication details, erection plans, plans for false work, form centering, cribs, cofferdams and masonry layouts; bending and placing drawings, and bar schedules for reinforcing steel and any other supplementary plans or similar data which the Contractor may be required to furnish.

00 45 00 REPRESENTATIONS AND CERTIFICATIONS

00 45 36.01 CONTRACT FORMS

The form identified as "Certification by proposed Subcontractor regarding equal employment opportunity", will be distributed to the Contractor at the prebid conference and through them to their Subcontractors. These forms shall be returned to the Engineer.

00 51 00 NOTICE OF AWARD

00 51 00.01 RIGHT TO REJECT BIDS

A. The Board of Estimates reserves the right and sole discretion to reject any and all Bids and/or to waive technical defects, if in its judgment, the interest of the City may so require.

B. No Bid will be considered from any person, firm or corporation who has defaulted in the performance or failed to perform satisfactorily any Contract or Agreement made with the City.

00 51 00.02 AWARD AS AN ENTIRETY

When Bid prices are asked for by items, the Contract will not be awarded by the items but will be awarded in its entirety on the basis of the "Bid total". The total must be the aggregate sum of the prices Bid on all the items; figured in the lump sum and unit price items, at the unit prices and approximate quantities named therefore. Bidders shall provide prices on all items.

00 51 00.03 AWARD OF CONTRACT

The award of the Contract, by the Board of Estimates, if it be awarded, will be made to the lowest pre-qualified responsive and responsible Bidder whose Bid complies with all the requirements prescribed. The successful Bidder will be notified by letter, mailed to the address shown in the Bid.

00 51 00.04 RETURN OF CERTIFIED CHECK

A. All bids shall remain open and subject to acceptance at any time for sixty (60) Calendar Days after the Bid opening and award of the Contract to the successful Bidder. However, the City may, in its sole discretion, release any Proposal and return the Proposal security prior to the expiration of the sixty (60) day period set forth above. The Bid security of the successful Bidder shall be retained until such Bidder has executed the Contract, furnished any required Contract security, and met the other conditions of the Notice of Award, whereupon the Proposal security will be returned. If the successful Bidder fails to execute and deliver the Contract and/or furnish the required Contract security, insurance certificates and other required information within ten (10) business days after receipt of the Notice of Award, the City may annul the Notice of Award without liability to Bidder; whereupon, the Proposal security of that proposer shall be forfeited to the City. The Bid security of other Bidders who the City believes have a reasonable chance of receiving the award may be retained by the City until seven (7) days after the effective date of the Agreement with the successful Bidder, or sixty (60) Calendar Days after opening of the Bids, whichever is earlier. The Bid security of Bidders whose Bids are not considered competitive will be returned within seven (7) days after the Bid opening and awarded to the successful Bidder.

B. In the case of Bid checks of less than five thousand dollars ($5,000), which have been deposited by the City, reimbursement will be made by the City in the amount of said check as indicated above.

00 51 00.05 UNRESPONSIVE AND UNBALANCED BIDS

To better ensure fair competition and to permit a determination of the lowest Bid, unresponsive Bids or unbalanced and/or conditional Bids may be rejected by the Board of Estimates at its sole discretion.

00 51 00.06 CONTRACT BOND

The successful Bidder shall be required to provide Payment performance Bonds on forms approved by the City from a Surety company licensed to do business in Maryland and listed as an approved Surety for projects in excess of the Bid amount on the U.S. Treasury's Circular 570, list of approved Sureties at the time of Proposal submission within ten (10) business days after the date of award of the Contract. Both the performance Bond and the Payment Bond shall be in the full amount of the total Contract Price, in the form attached to and made a part of the Bid forms and the Contract Documents.

00 51 00.07 CONTRACTOR TO EXECUTE REQUIRED DOCUMENTS AND START WORK PROMPTLY

The successful Bidder shall promptly execute a formal Contract, furnish the required Bonds, and all insurance policies and certificates or certified copies thereof issued in favor of the Mayor and City Council of Baltimore, as provided in the Special Provisions, all of which shall be subject to the approval of the City solicitor as to form, terms and conditions. Failure to comply with these requirements within ten (10) business days after the Award

shall be just cause for the annulment of the Award. It is understood and agreed that in the event of annulment of the Award, the Bidder shall immediately forfeit, to the use of the City, the amount of the certified check and/or Bid bond deposited with its Proposal, not as penalty, but as liquidated damages. As an alternative remedy, the City may elect to start the running of the Contract time (without allowing the Contractor to start work) or to pursue any other remedy allowed to the City under the law or equity.

00 51 00.08 SUBMISSIONS PRIOR TO AWARD

A. Prior to award, the Bidder must submit a Work capacity statement, under oath. These forms must be fully completed and returned within five (5) days after the date of receipt of those forms by the Contractor. The Work capacity statement shall show the volume of Work actually being performed for the City and for others as of the date Bid. The total dollar volume will be a charge against the Contractor's Work capacity after credit for Work performed has been allowed.

B. Subletting will be permitted within the limits of the Specifications when prequalified Subcontractors are proposed following the opening of Bids. Request for subletting by a Contractor must be accompanied by a Work capacity statement and consent of Surety for each Subcontractor requested. The Prime Contractor must perform at least fifty one percent (51%) of the Contract Bid total with its own forces.

C. Only prequalified Subcontractors will be approved to perform subcontract Work.

00 55 00 NOTICE TO PROCEED

00 55 00.01 NOTICE TO PROCEED AND PROSECUTION OF WORK

Subject to the provisions of 00 51 00.07 (Contractor to execute required documents and start Work promptly). The Contractor shall begin the Work to be performed under the Contract at the time and/or on the date stated in the "Notice to Proceed" given by the Engineer to the Contractor. Commencement of Work by the Contractor prior to Notice to Proceed shall be deemed and taken as a waiver of this notice on the Contractor's part, and the Contractor accepts sole responsibility for any such early commencement of Work prior to receipt of Notice to Proceed and the specified commencement date set forth therein. The place where the Work is to be started either will be stated in the Notice to Proceed or the Contract Documents and/or marked on the job site. The Work shall be prosecuted from as many different points, in such part or parts and at such times as may be directed and/or permitted in the Contract Documents, and shall be conducted in such a manner and with sufficient materials, equipment and labor as is considered necessary to insure its completion within the time set forth in the Contract Documents. Should the prosecution of the Work for any reason be discontinued by the Contractor with the consent of the Engineer, it shall notify the Engineer at least twenty-four (24) hours before again resuming operation.

00 73 00 ADDITIONAL CONDITIONS

00 73 16 INSURANCE

A. Original or certified copies of policies and certificates for any and all insurance required by the Specifications shall be submitted to the Engineer by the Contractor at the time it returns the signed copies of the Contract Documents for execution by City officials. All policies or certified copies thereof shall carry a forty-five (45) day advance notice of cancellation and opportunity to cure to the City.

B. The requiring of any and all insurance as set forth in these Specifications or elsewhere shall be in addition to and not in any way in substitution or in lieu of all the other protection provided under the Contract Documents.

C. No acceptance and/or approval of any insurance by the City and/or the Engineer shall be construed as relieving or excusing the Contractor or the Surety from any liability or obligation imposed upon either or both of them by the provisions of the Contract Documents and Bonds.

00 73 16.01 COMPENSATION, LIABILITY AND PROPERTY DAMAGE INSURANCE

A. Except as otherwise provided by law, the Contractor shall, at all times, maintain and keep in force such insurance as will protect it from claims under workmen's compensation acts, and also such insurance as will protect it and the City from any other claims for damages for personal injuries, including death, as well as from claims for damages to any property of the City or of the public, which may arise from operations, whether such operations be by the Contractor or by any Subcontractors, or anyone directly or indirectly employed by any of them.

B. Within ten (10) days after the award of the Contract, the Contractor shall be required, in addition to any other forms of insurance or Bonds required under the terms of the Contract and Specifications, to procure and maintain during the life of the Contract the types of insurance in the amounts set forth in the special conditions.

C. Payment for the aforesaid insurance will be made as provided in 01 29 76.

D. INSURANCE REQUIREMENTS

1. By the date of execution, the Contractor shall provide and maintain, insurance against claims for injuries to persons or damages to property which may arise from, or in connection with, the performance of Work hereunder by the Contractor, its agents, representatives, employees, and/or Subcontractors.
2. For all coverage: Each insurance policy will be written on an "occurrence" form; except that insurance on a "claims made" form may be acceptable with prior City approval.
3. If coverage is approved and purchased on a "claims made" basis, the Contractor warrants continuation of coverage either through policy renewals or the purchase of an extended discovery period from the date of Contract termination, and/or conversion from a "claims made" form to an "occurrence" coverage form.

E. COMMERCIAL GENERAL LIABILITY INSURANCE

1. The Contractor shall purchase and maintain commercial general liability insurance, at limits of not less than one million dollars ($1,000,000) per occurrence for all damages arising out of bodily injuries or death and property damage and with those policies with aggregate limits, a three million dollar ($3,000,000) aggregate limit is required. In case any Work is Subcontracted, the Contractor shall require the Subcontractor or anyone directly or indirectly employed by any of them to procure the same coverage.

   a. Such insurance shall include:

   1) Products – Completed operations insurance.
   2) Contractual liability insurance.
   3) Premises and operations insurance.

2. There shall be no exclusions pertaining to collapse of or damage to any building or structure, damage to underground property, or injury or damage arising out of blasting or explosion. The provision shall apply to operations by the Contractor or any Subcontractor.

F. BUSINESS AUTOMOBILE LIABILITY INSURANCE

The Contractor shall purchase and maintain business automobile liability insurance, at a limit of not less than one million dollars ($1,000,000) per occurrence for all damages arising out of bodily injuries or death and property damage. The insurance shall apply to any owned, hired or non-owned automobiles used.

G. SPECIAL HAZARDS INSURANCE

The Contractor shall purchase and maintain insurance in the event of the possibility of special hazards existing in the Work contemplated. Such hazards shall be covered by insurance in amounts not less than those required for all other provisions of this section. If any special hazards, including hazardous material, are encountered, the Contractor shall immediately notify the City. Prior to performing any further Work involving hazards, the Contractor will immediately purchase insurance subject to City review and approval.

H. WORKER'S COMPENSATION

The Contractor shall purchase and maintain worker's compensation coverage as required by the State of Maryland, as well as any similar coverage required for this Work by applicable federal or “other states” state law.

I. DEDUCTIBLES AND SELF-INSURED RETENTIONS

Any deductibles or self-insured retentions must be declared to, and approved by, the City. The deductible and/or self-insured retention of the policies shall be wholly the responsibility of the Contractor.

J. OTHER INSURANCE PROVISIONS

1. The insurance policies required in the Contract are to contain, or be endorsed to contain, the following provisions:
2. General liability policies

   a. The Mayor and City Council of Baltimore, its officers, officials, employees, project representatives, and agents (referred to as the "City") are to be covered as additional insured's with respect to liability arising out of activities performed by or on behalf of the Contractor.
   b. To the extent of the Contractor's negligence, the Contractor's insurance coverage shall be primary insurance with respect to the City, its officers, officials, employees and agents. Any insurance and/or self-insurance maintained by the City, its officers, officials, employees or agents shall not contribute to the Contractor's insurance or benefit the Contractor in any way.
   c. As to the interest of the City as additional insured, the insurance coverage afforded by the policy(ies) purchased by the Contractor as required shall not be cancelled, non-renewed, reduced in coverage or in limits, or invalidated due to any breach or violation by the named insured of any warranties, declarations or conditions, except for the exclusions in the policy, but this shall not prevent the reduction of the applicable aggregate limit by claims paid, until after forty-five (45) days prior written notice has been given to the City and opportunity to cure.
   d. The policy(ies) will automatically include and cover all phases of Work, equipment, persons, etc., which are normally covered while performing Work under the above Contract, whether specifically written therein or not.
   e. The insurance company(ies) providing insurance coverage as required herein is prohibited from pleading governmental function in the absence of any specific written authority by the City.

3. All Policies

   a. Coverage shall not be suspended, voided, canceled, reduced in coverage or in limits, except by the reduction of the applicable aggregate limit by claims paid, until after forty-five (45) days prior written notice has been given to the City and opportunity to cure.

K. ACCEPTABILITY OF INSURERS

1. Unless otherwise approved by the City, insurance is to be placed with insurers with Best's rating of no less than A:VIII, or, if not rated with Best's, with minimum surpluses the equivalent of Best's surplus size VIII and must be licensed and approved to do business in the State of Maryland.
2. If at any time the foregoing policies shall be or become unsatisfactory to the City as to form or substance, or if a company issuing any such policy shall be or become unsatisfactory to the City, the Contractor shall, upon notice to that effect from the City, promptly obtain a new policy and shall submit the same to the City, with appropriate certificates and endorsements, for approval.

L. VERIFICATION OF COVERAGE

The Contractor shall furnish the City with verification of insurance and endorsements as required. The certificates and endorsements for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf. The certificates and endorsements for each insurance policy are to be on forms approved by the City prior to the commencement of activities. The City reserves the right to require complete, certified copies of all required insurance policies at any time, such evidence of insurance shall refer to the project name and Contract number.

M. SUBCONTRACTORS

The Contractor shall include all Subcontractors as insured under its policies or shall furnish separate certificates of insurance and policy endorsements for each Subcontractor. Insurance coverages provided by Subcontractors as evidence of compliance with the insurance requirements, shall be subject to all of the requirements stated herein.

00 73 18 CONTRACTOR'S EXPENSE

A. Costs incurred by the Contractor for insurance, bond, permit fees, royalties, security, mobilization, etc., which are incident to lump sum Contracts shall be identified and included in the Contractor's schedule of payments when approved by the Engineer. Where itemized Contracts are involved, costs shall be identified and included in the lump sum breakdown for each bid item for approval by the Engineer, or the absence of such item, included in the several pay items appearing in the Bid.

B. All things required by the Contract Documents to be done, furnished and/or installed shall be done, furnished and/or installed by the Contractor, at its sole expense and cost unless otherwise provided therein.

C. The Contractor shall reimburse the City for inspection and all other services required when and if, the Contractor chooses to work in excess of the normal eight (8) hour workday, forty (40) hour work week, weekends, or on a City holiday. The amount due the City shall be deducted from the Contractor's monthly pay estimate at the hourly rate of thirteen dollars ($13.00). The rate specified is per inspector on the project while the overtime work is ongoing. The Contractor should assume that, if one (1) to two (2) crews are working, at least one (1) inspector will be on site. If three (3) to five (5) crews are working, at least two (2) inspectors will be on site. If more than five (5) crews are working, at least three (3) inspectors will be on site. This overtime reimbursement will not apply to overtime work done at the City's request due to no fault of Contractor.

00 73 19 HEALTH AND SAFETY REQUIREMENTS

A. The Contractor, and any and all of its Subcontractors, shall comply with the provisions, requirements, rules and regulations of the occupational safety and health laws of the State of Maryland.

B. The Engineer will report apparent violations of the occupational safety and health law to the Department of Public Works safety office for investigation and take such action as may be required.

C. The Contractor will submit a Health and Safety Plan for review by the City and designate an individual to serve as the Project Safety Officer.

00 73 43 WAGE RATE REQUIREMENTS AND HOURS

A. Hours:

1. Eight (8) hours shall constitute a regular work day for every laborer, mechanic and apprentice working directly upon the site of Work for any Contractor or Subcontractor engaged in the performance of the Contract. "Contractor", as used herein, shall mean the person, firm or corporation awarded a City Contract; "Subcontractor", as used herein, shall mean any person, firm or corporation, other than the Contractor, performing any Work upon the site of the project, whether Subcontractor, or lower tier Contractor.
2. All hours worked on Saturdays, Sundays and all hours worked in excess of eight (8) hours per day on Monday through Friday and all hours worked on such legal holidays as shall be designated by the Board of Estimates as overtime holidays constitute overtime hours.
3. The Minimum Hourly Wage Rate to be paid the classifications under schedule of Minimum Hourly Wage Rates for overtime, shall not be less than the prevailing hourly rate plus one half (1/2) the regular hourly rate. Overtime shall be (1) work that exceeds eight (8) hours in any one (1) Calendar Day, Monday through Friday; (2) work performed on Saturday; (3) work performed on Sunday; (4) and work performed on the holidays as follows: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day.

B. Classification:

Every such laborer, mechanic and apprentice shall be properly classified according to their trade and skill into a classification specifically set forth in the Contract which classification has been established by the Board of Estimates as provided herein.

C. Minimum Wages:

1. Every such mechanic, laborer and apprentice shall be paid not less often than once a week and without subsequent deduction or rebate on any account (except such payroll deductions as are directed or permitted by law, by a collective bargaining agreement, or by specific written authorization from an employee), the full amount due at the time of payment computed at wage rates not less than the minimum hourly wage rate established by the Board of Estimates and set forth in the Contract. No hourly employee, other than an apprentice, working directly upon the site of the Work, shall be paid less than the amount established for the lowest classification on the said project. A copy of such minimum hourly wage rates shall be kept posted by the Contractor at the site of the Work in a prominent place where it can be easily seen and read by the workers. In the event a copy of such minimum hourly wage rates is not posted, the Contractor shall forfeit and pay to

the City a penalty, in an amount set by the City, per day for each day on which the copy is not posted. Each day's violation shall constitute a separate offense.

2. The Contractor and every Subcontractor, shall pay every such laborer, mechanic or apprentice compensation at the overtime rates established by the Board of Estimates, which shall not be less than one and one-half (1-1/2) times the regular hourly rate of pay, for all hours worked in excess of eight (8) hours in any work day, on a Saturday, Sunday or a legal holiday designated as an overtime holiday by the Board of Estimates. No overtime hours, however, shall be compensated more than once and overtime shall be paid only on the regular hourly rate of pay and not on fringe benefits or their cash equivalents.
3. In the event that any such laborer, mechanic or apprentice shall be paid less than the compensation to which they shall be entitled hereunder, the Contractor shall make restitution to such affected employees, for the amount due, and shall forfeit and pay to the City a penalty, in an amount set by the City, per day for each employee so underpaid, provided, however, that no penalty shall be assessed for wage violations to any individual which amount to a total of less than one dollar ($1.00) in any payroll period. Each day's violation shall constitute a separate offense.
4. Any laborer, mechanic or apprentice may within one (1) year from the date of the incident file a protest, in writing, with the wage commission objecting to the amount of wages paid for services performed by them on a public project as being less than the prevailing wages for such services. It shall be unlawful for any Contractor, or Subcontractor, to discharge, reduce the compensation or otherwise discriminate against any such laborer, mechanic or apprentice for making a complaint to the wage commission, participating in any of its proceedings or availing itself of any civil remedies. In such a case, the wage commission may, pursuant to similar procedures as provided in the Baltimore City Code, as amended, order appropriate restitution or the reinstatement of such employee with back pay to the date of violation.
5. For the purpose of this section, contributions made or costs reasonably anticipated on behalf of laborers or mechanics, are considered wages paid to such laborers or mechanics, subject to the appropriate government provisions.
6. Also, for the purpose of this section, regular contributions made or costs incurred for more than a weekly period under plans, funds or programs, but covering the particular period, are deemed to be constructively made or incurred during such weekly period.
7. Any class of laborers or mechanics, including apprentices and trainees, which are not listed in the wage determination and which are to be employed under the Contract, shall be classified or reclassified conformably to the wage determination.
8. The City shall require whenever the minimum wage rate prescribed in the Contract for a class of laborers or mechanics includes a fringe benefit, which is not expressed as an hourly wage rate, and the Contractor is obligated to pay a cash equivalent of such a fringe benefit, an hourly cash equivalent, thereof to be established.
9. If the Contractor does not make payments to a trustee or other third person, it may consider as a part of the wages of any laborer or mechanic, the amount of any costs reasonably anticipated in providing benefits under a plan or program of a type expressly in the wage determination decision; provided however, the wage commission has found upon written request of the Contractor; that the applicable government standards have been met. The wage commission may require the

Contractor to set aside in a separate account, assets to meet the obligations under the plan or program.

D. Payroll and Basic Records:

1. The Contractor and each of its Subcontractors shall maintain payroll and basic records relating thereto during the course of the Work and shall preserve them for a period of three (3) years thereafter for all laborers, mechanics and apprentices working directly upon the site of the Work. Said records shall contain the name and address of each such employee, their classification in accordance with the classifications fixed in the Contract, a designation of laborer, mechanic or apprentice, the number of hours worked each day, the hourly wage rate, the gross wages, deductions made, actual wages paid, a copy of the social security returns and evidence of payment thereof, a record of fringe benefit payments including contributions to approved plans, funds or programs and/or additional cash payments, and such other data as may be required by the Board of Estimates from time to time.
2. The Contractor shall submit two (2) complete copies of its weekly project payroll and the weekly project payroll of each of its Subcontractors, consecutively numbered, not later than fourteen (14) days from the end of their respective payroll periods, one (1) copy to be sent to the Contracting agency, the other to the wage commission of Baltimore City, where the same will be available for public inspection during regular business hours. The weekly project payrolls shall contain the name of the Contractor and the Subcontractor, if any, a designation of the project and location, the name, social security number and occupation of each employee, their classification in accordance with the classifications fixed in the Contract, a designation of laborer, mechanic or apprentice, the number of hours worked daily by said employee at straight time and overtime and its hourly wage rate for each, the gross wages paid to said employee per week, and such other data as may be required by the Board of Estimates from time to time. The Contractor shall be responsible for the submission of all Subcontractors' payroll covering Work performed directly at the Work site. Each copy of the payroll shall be accompanied by a statement signed by the Contractor or Subcontractor, as the case may be, indicating that the payroll is correct, that the wage rates contained therein are not less than those established by the Board of Estimates as set forth in the Contract, that the classification set forth for each laborer, mechanic or apprentice conforms with the Work they performed and that the Contractor and the Subcontractor, as the case may be, have complied with the provisions of this subtitle.
3. If the Contractor is delinquent in submitting their or any of its Subcontractors' payrolls, processing of partial payment estimates may be held in abeyance pending receipt of the payrolls. In addition, if the Contractor is delinquent in submitting its or any of its Subcontractors' payrolls, the Contractor shall forfeit and pay to the City a penalty, in an amount set by the City, for each Calendar Day that the weekly payroll is late. A weekly payroll shall mean the combined payrolls of the Contractor and all of the Subcontractors in any one (1) workweek.
4. Send one (1) copy of all weekly project payrolls to the wage commission, and one (1) copy to the Engineer.
5. Such records shall include rates of contributions or costs anticipated and, daily and weekly number of hours worked. Insure that the wages of any laborer or mechanic includes the amount of any costs reasonably anticipated in providing benefits

under a plan or program described in federal statutes. The Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan is financially responsible, and that the plan or program has been communicated in writing to laborers or mechanics affected and records which show the cost anticipated, or the actual cost incurred, in providing such benefits.

6. The copy of the weekly payroll shall be accompanied by a statement signed by the employer or their agent, indicating that the payroll is correct and complete, that the wage rates contained therein are not less than those determined by the wage commission, and that the classifications set for each laborer or mechanic conform with the Work they performed. A submission of a weekly statement of compliance and the filing with the initial payroll or any subsequent payroll shall satisfy this requirement.

E. Apprentices:

1. On any project which is operating under a Contract pursuant to the provisions of this subtitle, only competent mechanics and their apprentices of the trade, crafts and occupations involved shall be employed by the Contractor and their Subcontractors on the project, provided that for each such project, the ratio of mechanics to apprentices for each trade, craft or occupation shall be as established by the Maryland Apprenticeship and Training Council in connection with an approved apprenticeship program.
2. Nothing in this subtitle shall prevent the employment of laborers to perform work not ordinarily performed by a skilled mechanic or their apprentice of the trade, craft, or occupation, but no person receiving the rate of pay which is the prevailing rate for laborers shall perform work ordinarily performed by any such skilled mechanic or apprentice of such trade, craft or occupation.
3. The term “apprentice" as used in this subtitle means a person of at least sixteen (16) years of age who has entered into a written agreement with an employer, or their agent, an association of employers or an organization of employers, or a joint committee representing both, and which shall state the trade, craft or occupation which the apprentice is to be taught, and the time at which the apprenticeship will begin and end, provided that whenever an apprentice is employed on any project which is operating under a Contract pursuant to the provisions of the subtitle, the wage commission shall be notified of such employment. All such apprenticeship agreements shall be approved by the Maryland Apprenticeship and Training Council and certification of such approval shall be furnished to the wage commission.
4. Where a laborer performs the work ordinarily performed by any skilled mechanic or their apprentice, they shall be paid for the entire time they have performed such work at the minimum hourly wage rate applicable to a skilled mechanic; and in the event of such under-payment, restitution shall be made by the Contractor to said employee and in addition, the Contractor shall be subject to a penalty as hereinafter set forth. If the Contractor or Subcontractor utilizes more apprentices than permitted under the ratio established under the provisions of this subtitle, or utilizes a laborer to perform the work of a skilled mechanic or their apprentice, the Contractor shall forfeit and pay to the City a penalty in an amount set by the City, per day for each such violation. Each day’s violation shall constitute a separate offense.

F. Withholding of Funds:

The City may withhold, or cause to be withheld, from the Contractor so much of the accrued payments as may be considered necessary (1) to pay such laborers, mechanics and apprentices employed by the Contractor or any Subcontractor the full amount of wages required by the provisions of this subtitle, and (2) to satisfy any liability of any Contractor or Subcontractor for any penalties as provided herein. The City may also withhold payment from any Contractor who has failed to post and keep posted a copy of the regular hourly rates as required herein, until such default shall have been corrected.

G. Enforcement:

1. It shall be the responsibility of the contracting agency to promptly examine all weekly project payrolls submitted by Contractors and Subcontractors working upon the job site for compliance with the provisions of this subtitle and the regulations promulgated in pursuance thereof and to report any irregularities to the wage commission.
2. The wage commission shall cause investigations to be made as may be necessary to determine whether there has been compliance with the provisions of this subtitle and the regulations promulgated thereunder, and contained in the Contract. The Contractor and Subcontractors shall permit representatives of the City to observe Work being performed at the Work site, to interview employees and to examine the books and records relating to the payrolls on the project being investigated to determine the correctness of classifications, ratios of apprentices to mechanics and payment of proper regular and overtime rates as required. Complaints of alleged violations shall be investigated promptly and statements, written or oral, made by an employee shall be treated as confidential and shall not be disclosed to their employer without the consent of the employee. If necessary for the enforcement of this subtitle the wage commission may issue subpoenas, compel the attendance and testimony of witnesses and the production of books, papers, records and documents relating to payroll records necessary for hearings, investigations and proceedings. Any such subpoena shall be served by the Sheriff of Baltimore City or any of its deputies. In case of disobedience to a subpoena, the wage commission may apply to a court of appropriate jurisdiction for an order requiring the attendance and testimony of witnesses and the production of books, papers, records and documents. Said court, in case of contumacy or refusal to obey any such subpoena, after notice to the person subpoenaed, and upon finding that the attendance or testimony of such witnesses or the production of such books, papers, records and documents, as the case may be, is relevant or necessary for such hearings, investigations or proceedings of the wage commission, may issue any order requiring the attendance or testimony of such witnesses or the production of such books, papers, records and documents, and any failure to obey such order of the court may be punishable by the court as contempt thereof.
3. In the event the Board of Estimates shall determine, upon recommendation from the wage commission after notice and hearing, that any Contractor or Subcontractor has failed to pay the minimum wage rate or has otherwise violated the provisions of this subtitle and that such failure was intentional, no Contract shall be awarded to such Contractor or Subcontractor, or to any firm, corporation or partnership in which such Contractor or Subcontractor has an interest until one (1) year has elapsed from the date of such determination, and provided, further, that

any such intentional violation of the provisions of this subtitle shall be a misdemeanor, punishable upon conviction by a fine of not more than five hundred dollars ($500.00). Proceedings before the wage commission shall not be considered a pre-condition to criminal prosecution under this subtitle.

[The word 'subtitle' in this section and wherever it may appear shall mean and be taken to mean the provisions of the appropriate Baltimore City Ordinance.] The remainder of the Ordinance follows:

H. Board of Estimates to Adopt, Review, and Revise:

1. The Board of Estimates is hereby authorized and empowered to adopt, establish, repeal, modify, change, or amend, from time to time, schedules of minimum hourly wage rates to be paid to any and all classes of laborers, mechanics, or apprentices directly employed by any Contractor or any Subcontractor on the site in any of the various types of work or projects mentioned in, or contemplated by, this subtitle.
2. Provided, however, that the schedules of minimum hourly wage rates so established shall be reviewed and revised by the Board of Estimates at least once every year to conform to the area prevailing hourly wage rates.

(a) Basis of revision

(1) Such revision may be based upon recommendations by the prevailing wage section of the wage commission.
(2) Such schedules of minimum hourly wage rates including overtime rates for all hours worked on Saturdays, Sundays, and all hours worked in excess of 8 hours per day on Monday through Friday and all hours worked on legal holidays designated as overtime holidays by the Board of Estimates shall not be less in amount than the general prevailing hourly wage rates being paid to laborers, mechanics, and apprentices for doing work of a similar character in the locality in which the project is located.
(3) And such general prevailing hourly wage rates shall be determined by the Board of Estimates whose decision in the matter shall be final.

(b) Authority of Board not restricted. Nothing in this ordinance shall be construed to limit or restrict in any way the power and authority of the Board of Estimates to classify the type of work to be done for the Mayor and City Council of Baltimore and to establish schedules of minimum hourly wage rates for such classifications established by the Board of Estimates.

I. "Minimum" and "Prevailing" Wage Rates Defined; Obligation to Pay:

1. Definitions

a. As used in this subtitle, the terms "minimum hourly wage rate(s)" and "prevailing hourly wage rate(s)" shall include:

(1) The regular hourly rate of pay; and
(2) The amount of:

(a) The rate of contribution irrevocably made by a Contractor, Subcontractor, or third person pursuant to a fund, plan, or program which provides for medical or hospital care, pensions on retirement or death, compensation for time lost from work due to injuries or illness, compensation for injuries or illness resulting from occupational activity, or insurance to provide any of the foregoing, for unemployment benefits, life insurance, or accident insurance, for vacation and holiday pay, for defraying costs of apprenticeship or other similar programs, or for other bona fide fringe benefits, but only where the Contractor or Subcontractor is not required by federal, state, or local law to provide any of the foregoing benefits; and

(b) The rate of costs to the Contractor or Subcontractor which may be incurred in providing the fringe benefits specified in subparagraph (A) to laborers, mechanics, and apprentices pursuant to an enforceable commitment to carry out a financially responsible plan or program which is communicated to the laborers, mechanics, and apprentices affected.

b. Provided, that the amount referred to in paragraph I, 1, a, (2), (a) shall be determined by the Board of Estimates on the basis of those fringe benefits found to be generally prevailing for laborers, mechanics, and apprentices doing work of a similar character in the locality in which the project is located. The decision of the Board of Estimates shall be final.

2. Obligation to Pay:

a. And provided further, that the obligation of a Contractor or Subcontractor to make payment in accordance with the schedules of minimum hourly wage rates established by the Board of Estimates and fixed in Contracts pursuant to this subtitle may be discharged by the making of payments in cash, by the making of contributions of any type referred to in subsection I, 1, a, (2), (a), or by the assumption of a plan or program of a type referred to in subsection I, 1, a, (2), (b), or any combination thereof, where the aggregate of any such payments, contributions, and costs is not less than the rate of pay described in subsection I, 1, a, (1) plus the amount referred to in subsection I, 1, a, (2).

J. Board of Estimates to Adjudicate and Assess:

1. In general, the Board of Estimates is hereby authorized and empowered to make any and all rules and regulations from time to time, that may be necessary to effectuate the purpose of this subtitle, including, but not limited to, the authority to make a final determination as to the amount of restitution and the amount of liquidated damages to be assessed for violations of the provisions of this subtitle.

2. Private action not precluded. In no event shall such determination of restitution preclude an employee from instituting suit to recover any underpayments due him.

K. Effect of Federal Law:

1. Agreements with federal government.

a. In case of any conflict between any provision of this subtitle or any minimum wage rate or any rule or regulation established or adopted by the Board of Estimates under the authority of this subtitle, and any provision of, or minimum wage rate or rule or regulation established by, contained or provided in, or contemplated by, any agreement, and any papers forming a part thereof, between the Mayor and City Council of Baltimore and the federal government, or any agency thereof, then the provision or minimum wage rate or rule or regulation of such agreement shall control.

2. Suspension of Davis-Bacon Act:

a. In the event that the provisions of the Federal Davis-Bacon Act are suspended as authorized by § 6 of said Act then the Board of Estimates, during the period of such suspension of the Davis-Bacon Act, may suspend the application of the provisions of this subtitle with respect to any project upon which the United States Secretary of Labor would have been required to make a prevailing wage determination under said Davis- Bacon Act.

b. Provided that if only a portion of a particular project requires a prevailing wage determination by the United States Secretary of Labor, the Board of Estimates may suspend the application of the provisions of this subtitle with respect to that portion only or with respect to the entire particular project in its discretion.

c. Provided, however, that nothing herein contained shall be deemed to affect in any manner the provisions of this subtitle as they apply to non-federally funded projects.

L. Existing Contracts Excepted:

Nothing contained herein shall in any manner affect or apply to any existing contract to which the Mayor and City Council of Baltimore is a party or to any contract that the Mayor and City Council of Baltimore may enter into pursuant to invitations for bids issued by the municipality prior to October 1, 1945.

M. Inconsistent Laws Repealed:

Any and all laws or ordinances and any and all parts of any and all laws or ordinances in force in the City of Baltimore inconsistent with the provisions of this subtitle are hereby repealed to the extent of any such inconsistency.

N. Severability:

In case it be judicially determined that any phrase, clause, sentence, paragraph, section or part in or of this subtitle, or the application thereof to any person or circumstance, is invalid, the remaining provisions and the application of such provisions to other persons or circumstances shall not be affected thereby, the Mayor and City Council hereby declaring

that they would have ordained the remaining provisions of this subtitle without the phrase, clause, sentence, paragraph, section or part, or the application thereof, so held invalid.

O. Effect of Repeal:

The repeal by this subtitle of any provision of law shall not revive any law heretofore repealed or superseded, nor shall any such repeal affect any act done, liability incurred, or any right accrued or vested, or affect, or abate, or prevent any right or penalty or punishment of any offense under the authority of such repealed laws.

00 73 44 APPRENTICES AND TRAINEES

A. Apprentices will be permitted to work as such only when they are registered individually, under a bona fide apprenticeship program, registered with a state apprenticeship agency, which is recognized, by the Bureau of Apprenticeship and Training, U.S. Department of Labor.

B. The allowable ratio of Apprentices to journeymen in any craft classification shall not be greater than the ratio permitted to the Contractor as to its entire work force under the registered program. Any employees listed on a payroll at the apprentice wage rate, who is not a Trainee as defined under 00 23 00, "Definitions of City Terms" or is not registered as above, shall be paid the Apprentice wage rate determined by the wage commission for the classification or work they actually performed. The Contractor, or Subcontractor, will be required to furnish to the City, written evidence of the registration of its program and apprentices, as well as of the appropriate ratios and wage rates, for the area of construction prior to using any Apprentices on the Contract Work.

C. Trainees will be permitted to work as such, when they are bona fide trainees employed pursuant to a program approved by the U.S. Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training, and in accordance with the provisions of the Code of Federal Regulations.

D. On contracts in excess of ten thousand dollars ($10,000), the employment of all laborers and mechanics, including apprentices and trainees, as defined under 00 23 00, "Definitions of City Terms", shall also be subject to the provisions of the Code of Federal Regulations. Apprentices and trainees shall be hired in accordance with the requirements of the Code of Federal Regulations.

E. The provisions of 00 73 43, "Wage Rate Requirements and Hours", shall be applicable to every invitation for Bids and to every negotiation, request for Bids, or request for quotations, for any construction Contract and to every such Contract entered into on the basis of such invitation or negotiation. Code of Federal Regulations shall constitute the conditions of each Contract in excess of ten thousand dollars ($10,000), and the City shall include these conditions or provide for their inclusion in each such contract.

00 73 45 ANTI-KICKBACK PROVISIONS

A. The provisions of this section prescribe 'Anti-Kickback' regulations under the Code of Federal Regulations.

B. Each Contractor or Subcontractor, shall furnish each week, a statement of compliance to accompany the weekly submission of payroll forms.

C. Upon a written finding by the United States Secretary of Labor or the City, reasonable limitations, variations, tolerances and exemptions from the requirements of this section may be provided, subject to such conditions as the Secretary of Labor or the City of Baltimore may specify.

D. Deductions made under the circumstances or in the situations described in the paragraphs of this section, may be made without application to and approval of the Secretary of Labor or the City of Baltimore:

1. Any deduction made in compliance with the requirements of federal and state withholding income taxes, and federal social security taxes.
2. Any deduction of sums previously paid to the employee as a bona fide prepayment of wages when such prepayment is made without discount or interest. A bona fide prepayment of wages are considered to have been advanced to the person employed in such a manner as to give them complete freedom of disposition of the advanced funds.
3. Any deduction of amounts required by court process to be paid to another, unless the deduction is in favor of the Contractor, Subcontractor or any affiliated person, or when collusion or collaboration exists.
4. Any deduction constituting a contribution on behalf of the person employed to funds established by the employer or representative of employees, or both, or the purpose of providing either from principal or income, or both. Medical or hospital care, pensions or annuities or retirement, death benefits, compensation for injuries, illness, accidents, sickness or disability, or for insurance to provide any of the foregoing or unemployment benefits, vacation pay, savings accounts or similar payments for the benefit of employees, their families and dependents; provided, however, that the following standards are met:
5. The deduction is not otherwise prohibited by law;
6. It is either:

    a. voluntarily consented to by the employee in writing, and in advance of the period in which the work is to be done and such consent is not a condition either for the obtaining of or for the continuation of employment, or
    b. provided for in a bona fide collective bargaining agreement between the Contractor or Subcontractor and representative of its employees;

7. No profit or other benefit is otherwise obtained directly or indirectly by the Contractor or Subcontractor or any affiliated person in the form of commission, dividend or otherwise; and
8. The deductions shall serve the convenience and interest of the employee.
9. Any deduction contributing toward the purchase of United States Defense Stamps and Bonds, when voluntarily authorized by the employee.
10. Any deduction requested by the employee to enable them to repay loans or to purchase shares in credit unions organized and operated in accordance with Federal and State Credit Union statutes.

11. Any deductions voluntarily authorized by the employee for making of contributions to governmental or quasi-governmental agencies.
12. Any deduction voluntarily authorized by the employee for making of contributions to community chest, united givers funds and similar charitable organizations.
13. Any deductions to pay regular union initiation fees and membership dues, not including fines or special assessments; provided, however, that a collective bargaining agreement between the Contractor or Subcontractor and representatives of its employees provided for such deductions and the deductions are not otherwise prohibited by law.
14. Any deductions not more than for the 'reasonable cost' of board, lodging or other facilities must meet the requirements of the Fair Labor Standards Act. When such a deduction is made, the additional records required are per the federal guidelines.

00 73 74.01 AMERICAN STEEL PRODUCTS REQUIREMENT

A. In accordance with the "Maryland Buy American Steel Act" (Annotated Code of Maryland, State Finance and Procurement Article), the Contractor or Subcontractor is required to supply only American steel products in the performance of work for:

1. Constructing or maintaining any improvements to real public property.
2. Buying or manufacturing machinery or equipment that is composed of at least hundred thousand (100,000) pounds (lbs) of steel product that is to be installed at a public work site.

B. Exceptions are noted in the statute.

00 73 75.01 COOPERATION OF CONTRACTOR REQUIRED

A. The Contractor will be supplied, by the Engineer, copies of the Plans and Specifications, and it shall have available on the Project at all times during the prosecution of the Work one (1) copy each of the Plans and Specifications. The Contractor shall give the Work its constant attention to facilitate the progress thereof, and shall cooperate with the Engineer in every way possible.

B. The Contractor shall assign to the Contract, as its agent, a full time competent English speaking Superintendent, or foreman, capable of reading and thoroughly understanding the Plans and Specifications and thoroughly experienced in the type of Work being performed. The Superintendent shall be acceptable to the Engineer, and upon the Engineer's request, the Contractor shall submit a document outlining the Superintendent's qualifications and experience. The Superintendent shall be present at all times during the working hours. The Superintendent shall represent the Contractor in its absence, and all directions given to it by the Engineer shall be as binding as if given to the Contractor directly. The Superintendent, or foreman, shall have full authority to execute the orders, or directions, of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. A Superintendent shall be furnished irrespective of the amount of Work sublet. The Superintendent shall not be removed by the Contractor until the completion of the Work, unless for just cause with the approval of the Engineer.

C. The City reserves the right to enter into other Contracts for Work or materials to be constructed in or about the Project herein described and to order the starting and progress of such other Contracts at any time prior to the completion of the Contract, and the Contractor for the Project herein described agrees to allow the construction or progress of the Work under such other Contracts under such arrangements for the occupation of the site as the Engineer may approve. The Contractor shall therefore be prepared to prosecute its Work wherever and whenever it may be practicable and shall not delay its commencement or progress awaiting the completion of any other Contracts, but will be required to perform wherever possible and concurrently with them and cooperate with other Contractors to the end that the several systems and Contracts shall not interfere with each other and that the Work may present a neat, orderly and finished appearance as a whole when completed.

D. The Contractor shall cooperate with others performing Work connected with or adjacent to the Work and shall afford them reasonable opportunity to perform.

E. The Contractor hereby waives any claim for damages or extra compensation by reason of any interference with its Work; but if, in the judgment of the Engineer, the joint occupation of the site by two (2) or more Contractors, or different Contracts at the same time, actually impedes the progress of the Work, then the Engineer may extend the time for its completion.

F. In case of disputes arising between the Contractors on different Contracts, on or adjacent to the site of the Work, the decision of the Engineer shall be final and binding upon the Contractors, insofar as the Engineer has authority.

G. The provisions of this paragraph as to other Work done, or to be done, on behalf of the City shall also apply to Work done, or to be done, by the City with its own forces.

00 73 76 DAMAGE TO PROPERTY

A. The Contractor's attention is directed to the fact that public (City-owned) equipment may be in use by inspection personnel on the Project. The Contractor shall be responsible for the protection of such City-owned equipment.

B. In case any direct or indirect damage or injury is done to public or private property by or because of the Work or in consequence of any act or omission on the part of the Contractor, its employees, agents, and/or Subcontractors, the Contractor shall, at its own expense, restore such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise, as may be required by the Engineer; or shall make good such damage or injury in a satisfactory manner; and, in case of failure on the part of the Contractor to restore promptly such property or make good such damage or injury, the Engineer may, upon forty-eight (48) hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be necessary, and the cost thereof, may be deducted from any monies due or to become due the Contractor, or under the Contract a sum sufficient, in the judgment of the Engineer, to reimburse the owners of the property so damaged or injured.

00 73 77 USE OF A PORTION OF THE WORK

A. Whenever, in the opinion of the Engineer, any portion of the Work is completed or is in acceptable condition for use, it may be used for its intended purpose, as may be directed, and such use shall not be held to be in any way an acceptance of that portion of the Work used, or as a waiver of any of the provisions of the Contract Documents.

B. Necessary repairs or renewals made in any section of the Work, under instruction from the Engineer, due to defective materials or Work, natural causes, to ordinary wear and tear, or otherwise, pending final completion and acceptance of the Work, shall be performed at the expense of the Contractor.

00 73 78 TEMPORARY SUSPENSION OF WORK

The Engineer shall have the authority but not the obligation to suspend the Work, wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather or such other conditions as are considered unfavorable for the suitable prosecution of the Work, or for such time as is necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the Contract. If it should become necessary to stop the Work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and the Contractor shall take every precaution to prevent destruction, damage, or deterioration of the Work performed, provide suitable drainage by opening ditches, shoulder drains, etc., and erect temporary structures where necessary at its sole costs and expense. The Contractor shall not suspend the Work without advance, written authorization from the Engineer. Neither the failure of the Engineer to notify the Contractor to suspend Work on account of bad weather or other unfavorable conditions, nor permission by the Engineer to continue Work during bad weather or other unfavorable conditions, shall be cause for the acceptance of any Work which does not comply in every respect with the Contract and Specifications, or any claim by the Contractor for additional compensation.

00 73 79 TERMINATION FOR DEFAULT OF CONTRACT

A. If the Contractor fails to begin the Work under the Contract within the time specified, or fails to perform the Work with sufficient skilled workers and proper equipment and/or with sufficient proper materials to insure the prompt completion of said Work, except in cases for which an extension of time is provided, or shall perform the Work unsuitably or neglect or refuse to promptly remove materials or again promptly perform such Work as shall be rejected as defective or unsuitable or shall discontinue the prosecution of the Work without due authorization, or if the Contractor shall become insolvent or be declared bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against it unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or shall fail to make prompt payment to all Subcontractors and/or material, and/or labor supplied, or shall persistently disregard any state, federal, local or municipal laws, ordinances, rules and regulations pertaining to the Work, or shall disregard the instructions, orders or directions of the Engineer, or from any other cause whatsoever shall not carry on the Work in an acceptable manner, the Engineer may give notice in writing, mailed to the Contractor and/or its Surety of such delay, neglect or default, specifying the date, and if the Contractor within a period of three (3) days after such written notice is

mailed, shall not proceed in accordance therewith, then the City shall, upon written certificate from the Engineer of the fact of such delay, neglect or default, and the Contractor's failure to comply with such notice, have full power and authority, without prejudice to any of its other rights or remedies and without violating the Contract, terminate the employment of the Contractor and take the prosecution of the Work out of the hands of said Contractor, and take possession of the premises and appropriate or use any or all materials, appliances and equipment on the premises, and may enter into an agreement for the completion of said Contract according to the terms and provisions thereof, or use such other methods as, in its sole opinion, shall be deemed expedient and necessary for the completion of said Contract in accordance with the Plans and Specifications and within such time as in the judgment of the City, the public interests may require.

B. In the event of any of the aforesaid circumstances arising at any time or times, the City shall have the right to withhold, without the payment of interest, any sum or sums of money due to Contractor until the interests of the City have been fully protected to the satisfaction of the Engineer. All costs and expenses incurred by the City, including without limitation fees and costs of attorneys, consultants or other contractors, together with the costs of completing the Work under the Contract, including the cost of additional managerial and administrative services, if any, shall be deducted from any monies due to said Contractor. In case the expense so incurred by the City shall be less than the sum which would have been payable under the Contract if it had been completed by said Contractor, then the said Contractor shall be entitled to receive the difference. In the event such costs and expenses shall exceed the sum which would have been payable under the Contract, the Contractor and/or the Surety shall be liable therefore, and shall pay the amount of the difference to the City within ten (10) days after written notice is mailed to the Contractor and/or Surety. The expense, loss or damage, including the cost of additional managerial and administrative services, if any, incurred by the City through the Contractor's default shall be certified by the Engineer, and such certifications shall be conclusive and recognized and accepted as the correct amount of the loss sustained by the City and/or all parties concerned.

00 73 80 NO ESTOPPELS OR WAIVER OF LEGAL RIGHTS

The City, or the Engineer, shall not be precluded or stopped by any measurement, estimate or certificate, made or given by them, or by any agent or employee of the City, under any provision or provisions of the Contract, at any time, either before or after the completion and acceptance of the Work and payment therefore pursuant to any measurement, estimate or certificate, from showing the true and correct amount and character of the Work performed and materials furnished by the Contractor, or from showing at any time that any such measurement estimate or certificate is untrue or incorrectly made or that the Work or materials or any part thereof do not conform in fact to the requirements of the Contract Documents. The Engineer shall have the right to reject the whole or any part of the aforesaid Work or materials should the said measurement, estimate, certificate or payment be found or be known to be inconsistent with the terms of the Contract Documents, or otherwise improperly given, and the City shall not be precluded and estopped, notwithstanding any such measurement, estimate, certificate and payment in accordance therewith from demanding and recovering from the Contractor and its Surety such damages as it may sustain by reason of the Contractor's failure to comply with the terms of the Contract Documents. Neither the acceptance by the City, the Engineer or any agent or employee of the City, nor any certificate by the City for payment

of money, nor any payment for nonacceptance of the whole or any part of the Work by the City or the Engineer, nor any extension of time, nor any possession taken by the City or its employees, shall operate as a waiver of any portion of the Contract Documents or of any power herein reserved by the City, or any right to damage herein provided, nor shall any waiver of any breach of the Contract Documents be held to be a waiver of any other or subsequent breach.

00 73 81 SUB-LETTING OR ASSIGNING OF CONTRACT

A. The Contractor shall give its personal attention constantly to the faithful performance of the Work, shall keep the same under its own control, and shall not assign the Contract by power of attorney or otherwise, nor sublet the Work or any part thereof, without the previous written consent of the Engineer. The Contractor shall state to the Engineer, in writing, the name of each Subcontractor it intends employing, the portion of the Work which each Subcontractor is to do, their place of business and such other information as the Engineer may require, in order to know whether such Subcontractors are reputable and reliable, and able to perform the Work or to furnish the materials as called for in the Specifications. Only Subcontractors pre-qualified in accordance with 00 21 13.20 shall be allowed at the Work area or allowed to furnish labor. A Subcontractor may not sublet Work assigned to it.

B. The Contractor shall perform with its own organization, Work amounting to not less than fifty-one percent (51%) of the remainder obtained by subtracting from the total original Contract value the sum of any items designated in the Contract as “specialty items” and/or MWBOO requirements.

C. The Contractor shall not, either legally or equitably, assign any of the monies payable under the Contract, or its claims thereto, unless by and with the like consent of the Engineer.

D. The Contractor shall not be released from any of its liabilities or obligations under its Contract should any Subcontractors fail to perform in a satisfactory manner the Work undertaken by them.

E. The Contractor agrees that it is as fully responsible to the City for the acts and omissions of its Subcontractors, suppliers, consultants, and of persons either directly or indirectly employed by them, as it is for the acts and omissions of those directly employed by it.

F. Nothing contained in the Contract Documents shall create any contractual relation between any Subcontractor and the City.

G. No Subcontractor will be considered for approval, unless the Contractor submits the Maryland State License Number of the Subcontractor. The Contractor’s attention is hereby directed to 01 41 26 “Permits, Licenses, Charges and Notices”, in the general conditions.

H. All Subcontractors on this project must be pre-qualified by the City of Baltimore in accordance with the procedures adopted by the Board of Estimates.

I. If a payment and performance Bond is required by the Contractor, the cost of such bond will be paid for by the Contractor.

J. All proposed Subcontractors must submit a Work Capacity Statement prior to beginning Work on the project.

00 73 82 CONTRACT TIME FOR COMPLETION OF THE WORK

A. The Contractor accepts this Contract with the understanding and intention to perform fully, entirely and in an acceptable manner the Work contracted for within the time stipulated in the Bid, accounting from the date provided for in 00 55 00.01, "Notice to Proceed and Prosecution of Work". The Contract time is on a Calendar Day basis and it shall consist of the number of consecutive Calendar Days stated in the Contract, including all Sundays, holidays, and non-work days. Time is of the essence of this Contract.

B. The Contractor shall complete the Work in the number of Calendar Days indicated in the Bid Book and Contract Documents, if subsequently amended by Change Order, or shall be considered in default under the terms of the Contract. If the Contractor is so considered in default, then Contractor and its Surety shall then be required to pay the City an amount/sum equal to the daily amount of liquidated damages as specified in the Contract multiplied by the number of days the Work remained incomplete past the approved Contract completion date. The parties mutually acknowledge and agree that the amount/sum stipulated in the Contract as liquidated damages is based on a reasonable forecast of the damages the City would incur on a daily basis as a result of the Work not being completed by the approved Contract completion date, and is not intended to be nor shall it be construed by either party to be a penalty for late completion of the Work. This amount/sum will be deducted from the monthly and/or final payments on the Contract, unless such time extension and/or waiver of liquidated damages is approved by the City and the Board of Estimates. The decision of the Board of Estimates shall be final, conclusive and binding upon the Contractor.

C. Any Contractor wishing to extend the number of Calendar Days of its Contract shall make written application thereof, in writing, addressed to the Engineer within ten (10) days after the occurrence of the event for which such allowance is claimed, or be deemed to have forever and unconditionally waived and released any such time extension request, claim and/or costs and expenses arising out of or relating to any such actual or alleged delay.

D. If the beginning or prosecution of the Work shall be delayed or suspended in consequence of any act or omission of the City, and not by any fault of the Contractor, then subject to other provisions of the Contract Documents, the time for completion of the Work shall be increased by a period of time equal to the aggregate actual time, expressed in Calendar Days and parts of days during which the beginning or prosecution of critical path Work has been so delayed or suspended.

E. No allowance shall be made for delay or suspension of the prosecution of the Work due to the fault of the Contractor.

F. Notwithstanding any other provisions of the Contract Documents, Contractor agrees that in no event shall it make a claim or other demand against the City for any delay, disruption or hindrance to the prosecution of the Work unless Contractor is subjected to a complete and full work stoppage resulting in a continuous delay, disruption or hindrance in the prosecution of critical path Work of forty-five (45) days or longer due to causes beyond its fault or control, in whole or in part. In the event a Contractor actually experiences a delay,

disruption or hindrance in the prosecution of critical path Work of forty-five (45) days or longer due to causes beyond its fault or control, in whole or in part, the Contractor shall be entitled to recover the direct damages resulting therefrom, exclusive of profit or overhead. Except as may be expressly provided herein, in no event shall the Contractor be entitled to indirect, consequential or punitive damages from the City, including without limitation loss of profit, loss of business opportunity, and/or loss of bonding capacity arising out of or relating in any way to any delay, disruption, hindrance or any other actual or alleged breach of contract or other act or omission of the City or any of its officials, officers, employees, agents, consultants, separate contractors, or representatives.

00 73 83 FAILURE TO COMPLETE WORK ON TIME AND LIQUIDATED DAMAGES

Should the Contractor fail to complete fully, and to all intents and purposes, the Work as specified in the Contract Documents on or before the time required therein, inclusive of any authorized extensions thereof, the Contractor shall pay to the City such sum, as specified in the Contract Documents, for each and every consecutive Calendar Day thereafter and until and including the day when the said Work shall be completed to all intents and purposes as specified to the satisfaction of the Engineer, which sum is hereby agreed upon, not as a penalty, but as liquidated damages which the City has suffered by reason of such failure by the Contractor; provided, that the Board of Estimates shall have the right at their discretion to extend the time for the completion of the Work beyond the time herein stated. The City shall be fully authorized and empowered to deduct and retain the amount of any damages, determined as stated before, for each consecutive Calendar Day that the Contractor shall be in default in completing the Work after the time fixed in the Contract, or after any later date to which the time for completion may have been extended by the Board of Estimates, from any monies due or to become due to the Contractor under the provisions of the Contract at any time after such damages are so incurred. The permitting of the Contractor to go and finish the Work or any part of it after the time fixed for its completion, or after the date to which the time for completion may be extended, shall in no way operate as a waiver on the part of the City of any of the City's rights under the Contract.

00 73 84 CLAIMS OR DISPUTES

A. To prevent disputes and litigation the exclusive procedures for the prosecution and resolution of all claims and disputes under the Contract.

1. PROMPT NOTICE OF CLAIM OR DISPUTE

a. Should the Contractor be of the opinion, at any time, that it is entitled to any additional Contract time and/or compensation whatsoever exceeding the compensation stipulated in the Contract Documents in the form of damages, losses, time, costs and/or expenses, alleged to have been sustained, suffered or incurred by it in connection with the Project, the Contractor shall in each instance request this fact to be entered on the Project daily logs as set forth above and within ten (10) Calendar Days thereafter shall file a written notice of the claim with the Engineer. Within thirty (30) days after this Work upon which the claims is based is completed, the Contractor shall file a written itemized statement of the factual and contractual details, amount, and supporting documents relating

to each such claim including without limitation the time (substantiated by a time impact analysis), damage, loss, cost and/or expenses purportedly incurred and requested, and unless such notice, claim and statement shall be thus made and filed, in each instance, as set forth herein, the Contractor's claim for such additional time and/or compensation shall be held and taken to be invalidated and forever and unconditionally waived and released, and it shall not be entitled to any compensation or time whatsoever on account of such alleged claim of time, damage, loss, cost and/or expense. Reasonable extension of the thirty (30) Calendar Day period set forth above may be granted by the Engineer, at the Engineer's sole discretion, upon receipt of a written request for such extension from the Contractor, accompanied by sufficient proof of its inability to obtain statements and/or other details due to circumstances beyond its fault or control.

b. The conditions of this section shall be held and taken to constitute a condition precedent to the right of the Contractor to prosecute a claim and recover additional time or cost notwithstanding any provisions of the Contract Documents. They shall also apply to all claims by the Contractor in any way arising out of or relating to the complete project or portions of the project, even though claims and or work involved may be regarded as "outside the Contract".

c. It is further understood and agreed, however, that nothing in this section shall be held or taken to enlarge in any way the rights of the Contractor or the obligations of the City under the Contract Documents.

2. INITIAL REVIEW OF CLAIM OR DISPUTE

a. The Inspector assigned to the project, the Engineer, and the Division Head of Construction Management (and/or any individual or entity designated by the Head) shall each review the substance of the said claim and may request additional information from the Contractor. The Contractor shall fully and completely respond to all such requests for additional information within five (5) business days from its receipt of any such written request for additional claim or be deemed to have forfeited its right to recovery of additional time or costs in connection with the claim or dispute.

b. Where appropriate the Division Head may resolve the claim through negotiation at its sole discretion.

c. The Division Head may resolve the claim in whole or in part; or deny the claim in whole or in part.

d. Any claims that are denied in whole or in part, unless otherwise waived by the Contractor, must be appealed in writing by the Contractor to the Engineer within thirty (30) days of the date of a written denial being issued by the Division Head as a condition precedent to the Contractor's right to further prosecute the claim.

3. REVIEW BY HEAD OF BUREAU

a. Claims and/or disputes appealed to the Bureau Head shall be reviewed and resolved in a timely manner, which shall depend upon the complexity and circumstances of the claim(s).

b. The Bureau Head shall have all of the authority and powers to settle disputes that are not settled by the Division Head to resolve the matter.

c. Disputes and/or claims that are not resolved and/or settled by the Bureau Head to the satisfaction of the Contractor may be reserved by the Contractor for final review by the Director by giving written notification to the Director within thirty (30) days of the date of the written decision of the Bureau Head, with such thirty (30) days written notification being a condition precedent to the Contractor's right to further prosecute the claim or dispute.

4. REVIEWS BY THE DIRECTOR OF THE APPLICABLE DEPARTMENT

a. The Director of the applicable department shall act as the Hearing Officer and shall hold one (1) administrative hearing on the record at the conclusion of the Work on the Contract to resolve any and all claims and/or disputes, which have been timely, appealed to the Director, pursuant to these procedures.
b. The cost of transcription shall be borne equally among the parties.
c. The decision of the Director is final and conclusive, but is subject to review on the record by a court of competent jurisdiction pursuant to the Baltimore City Charter.

00 73 85 NO DAMAGES TO BE CLAIMED FOR DELAY

Except as otherwise expressly set forth herein, no claims for damages shall be made or allowed on account of postponement or delay occasioned by the precedence of paving or other Contracts which may be either let or executed before the execution of the Contract, or on account of the streets or structures adjacent to the Work not being in the condition contemplated by the parties at the time of making the Contract, or on account or delay in the removal of obstructions, beyond the time herein before specified, or by reason of the Work, or any part thereof being suspended on account of paving or other Contracts. However, if the Contractor shall be delayed in the performance of its Work by reason of any or all of said causes beyond the time herein specified, subject to the Contractor's compliance with other provisions of the Contract Documents with regard to notice and prosecution of claims, such allowance of time will be made as the Engineer shall deem reasonable.

DIVISION 01
GENERAL CONDITIONS

01 11 00 SUMMARY OF WORK

01 11 13.01 INTENT OF SPECIFICATIONS

A. The intent of these Specifications and other Contract Documents is that the Work to be performed by the Contractor shall be neat, finished, full and complete in every detail, and ready for use and operation for the purpose for which it is intended. The Contractor shall furnish all labor, tools, implements, materials, machinery and equipment necessary, except as otherwise noted on the Plans and/or in the Specifications to complete the Project. Should any Work or material be required which is not noted in the Contract Documents either directly or indirectly, but which is nevertheless, necessary for the proper carrying out of the intent thereof, it is understood and agreed that the Contractor shall perform all such Work and furnish all such materials as fully as if they were completely delineated and prescribed at no additional costs or expense to the City.

B. All incidental minor and miscellaneous items, Work and materials for which no payment is specifically provided, and any items, Work and materials not specified or shown in the Contract Documents which are necessary to complete the Work and to maintain and/or repair the Work, shall be done and furnished by the Contractor without extra charge. Anything shown on the Drawings and not mentioned in the Specifications or mentioned in the Specifications and not shown on the Drawings shall have the same effect as if shown or mentioned respectively in both. Any conflict or inconsistency in the Contract Documents shall be submitted by the Contractor to the Engineer in writing and sufficiently in advance of the scheduled performance of Work that will or may be affected so as to permit the Engineer time to study the issue and render a decision thereon so as to avoid or mitigate the time and/or cost impact of any such issues. All such decisions rendered by the Engineer shall be conclusive.

01 11 13.02 PLANS TO BE FOLLOWED

The approved plans, profiles and cross-sections on file in the office of the Engineer will show the location, details and dimensions of the Work contemplated, which shall be performed in strict accordance therewith, the Specifications, and all other Contract Documents. There shall be no deviation from the Plans or Specifications on account of the exigencies of construction, unless approved in advance by the Engineer and authorized in writing.

01 11 14 PRECONSTRUCTION MEETING

The successful Bidder shall be notified through the "Notice to Proceed" of the date, time and location of the preconstruction meeting. The Engineer will schedule the preconstruction meeting to review responsibilities, procedures and personnel assignments. The Engineer shall include all pertinent City agency representatives, including, but not limited to, the Tree Protection Expert, and agency representative for real property.

01 11 15 INTERPRETATION OF PLANS

On all Plans and Drawings the figured dimensions shall take precedence and govern over scaled dimensions, and large scale Drawings shall take precedence and govern over small. Repetitive features not completely described and/or detailed shall be construed in accordance with corresponding features that are completely described and/or detailed. The Contractor shall take no advantage of any error or omission in the Plans or of any discrepancy between the Plans and Specifications, and the Engineer shall make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the Specifications and of the Plans as construed by the Engineer. In all cases of doubt as to the true meaning of the Specifications, Plans and/or Drawings, the decision of the Engineer will be final and conclusive. Where variances occur between the Drawings and Specifications or within either Document, or if Work required is detailed in the Contract Documents so as to render it impossible for the Contractor to produce first class Work or where the Contractor believes that there is insufficient detail contained in the Drawings and Specifications from which to make a proper determination as to their intent, the Contractor shall bring all such matters to the immediate attention of the Engineer in writing, via the RFI process, for clarification or other decision as provided in the Contract Documents. The Engineer shall determine which Document takes precedence, or will give instructions as to the intent of the Contract Documents. Failure of the Contractor to bring such variances of which it knew or should have known, to the immediate attention of the Engineer, shall constitute an unconditional waiver and release of any claim for additional cost or time based on the Engineer's interpretation of the Drawings and/or Specifications.

01 11 15.10 EXPLANATION OF DRAWINGS AND SPECIFICATIONS

A. In all cases of doubt as to the true meaning of the Specifications and/or Drawings, the decision of the Engineer will be final and conclusive.

B. The Drawings and Specifications are to augment each other, and are to be considered as one and not as a part. Anything mentioned in one and not in the other, or shown on one of the Drawings and not on the other, is to be furnished and done. The general character of the detail Work is shown on the Drawings and the Contractor shall not commence any part of the Work until the details of the same have been approved, when such are not presented herewith.

C. Parts not shown on the Drawings are to be in accordance with corresponding parts which are shown.

D. The Contractor shall carefully study and compare all Drawings, Specifications and other instructions and actual conditions at the site, and shall report in writing at once to the Engineer any error, inconsistency or omission, which it discovers or should have discovered with exercise of reasonable care.

E. Figures in all cases are to be followed in preference to direct measurements from the Drawings, but all figures must be checked against existing conditions as set forth in paragraph (D).

F. Figures given on feature scale Drawings and full-size details are to take precedence over those on general Drawings.

G. The Contractor shall abide by and comply with the true intent of the Drawings and Specifications and not take advantage of any unintentional error or omission, but shall fully complete every part as to the true intent and meaning of the Drawings and Specifications, as decided by the Engineer.

H. In the event of conflicts among the Contract Documents, the Engineer may designate the written or drawn provisions or feature which shall control and no additions to or deductions from the Contract sum or Contract Time for completion shall result from that choice. In case of conflicts, the Contract Specifications, Contract Drawings and City Specifications will be reviewed to resolve any disputes.

01 11 15.11 DATUM

A. All elevations mentioned herein or shown on the Drawings are referred to mean low tide as adopted by the Baltimore survey control system.

B. All courses and coordinates mentioned herein or shown on the Drawings are referred to the true meridian as adopted by the Baltimore survey control system.

01 14 00 WORK RESTRICTIONS

01 14 14 RIGHTS OF WAY

Where the Work called for extends upon or through private property, the City will procure all necessary rights and deeds for access to and use of such property and the Contractor shall not proceed with this part of the Work until the City has completed its negotiations with the property holders.

01 14 17 NIGHT WORK

A. Unless otherwise specified or directed by the Engineer, the regular working day shall begin no earlier than 7:00 A.M.

B. No night work between the hours of sundown and sunrise shall be permitted except in cases of emergency, and then only by written permission of the Engineer.

01 14 18 GENERAL WORK HOURS

Except as otherwise specified in the Special Provisions or other Contract Documents, or directed by the Engineer, the regular eight (8) hour working day shall begin no earlier than 7:00 A.M. and end no later than 5:00 P.M.

01 14 20 CITY PROPERTY AND STREETS

The Contractor may use only such City property and streets as may be designated by the Engineer for the storage of materials, for erection and maintenance of offices, sheds and other temporary structures, for hauling materials and equipment, for stockpiling excavated materials or for any other purpose necessary in the performance of the Work. Upon completion of the Work, the Contractor shall, at its own expense, restore such property and streets to a condition equal to that existing at the time the Contractor began to use same.

01 14 21 SUNDAY AND HOLIDAY WORK

A. No Work requiring the presence of an Engineer or Inspector shall be permitted on Sunday except in cases of emergency, and then only to such extent as is absolutely necessary and with advance written permission of the Engineer.

B. The Contractor will not be permitted to work on the following days, which are legal holidays in the City of Baltimore, except in cases of emergency, and in all such cases of emergency the written permission of the Engineer must first be obtained: New Years Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; and Christmas Day.

C. In case the Contractor desires to work upon any legal holiday listed herein, it shall so inform the Engineer in writing at least two (2) days in advance of such holiday. The Contractor shall indicate the nature of the emergency, its desire to work, the location at which Work will be conducted and its intent to comply with the provisions of the paragraph 00 73 43, "Wage Rate Requirements and Hours" pertaining to premium pay for overtime, Saturday, Sunday and holiday work. If any holiday listed above falls on a Sunday, the following Monday shall be considered a holiday.

01 14 23 NOISY WORK

No operating of hoisting or other engines or other work of a noisy character will be permitted between the hours of 11:00 P.M. and 7:00 A.M. except in case of great emergency, and then only with the written consent of the Engineer and to such extent as they may judge it to be necessary. Noise levels should not exceed 55 decibels at the nearest property line after 11:00 P.M.

01 23 00 ALTERNATES

01 23 27 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

A. The Contractor, with the written approval of the Engineer, may use in the proposed construction such stone, gravel, sand or other materials determined suitable by the Engineer as may be found in the excavation. The payment for excavation of these materials and the use or reuse as fill within the specified Contract limits shall be included in the Bid schedule of values for which the excavation/backfill is needed. Contractor shall, at its own expense, replace with other acceptable material all of that portion of the excavation material so removed and used. The above-mentioned basis of payment shall

not apply to materials meeting the requirements of borrow, select borrow or special borrow that are found in the excavation and are used for capping in cuts or embankments to replace Class 1-A Excavation because in such cases the only payment the Contractor will receive shall be for the excavation at the corresponding unit price.

B. The Contractor shall not excavate or remove any material from within the highway location which is not within the excavation, as indicated by the slope and grade lines, without prior written authorization from the Engineer.

C. Unless otherwise provided, the material from any existing old structure may be used temporarily by the Contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer.

01 25 00 SUBSTITUTION PROCEDURES

01 25 13 EQUAL OR APPROVED EQUAL

A. On City Contracts the terms "or equal" and "substitution" are to be considered interchangeable. Where any item or material is specified by proprietary name, the trade names, and/or name of manufacturer, with or without the addition of such expressions as "or equal" or "approved equal", it is to be understood that the item or material named or the equal thereof, is intended, subject to the advance written approval of the Engineer as to the equality thereof, and it is distinctly and expressly understood by the Contractor.

1. That the Engineer is to use his own judgment in determining, from time to time, whether or not any item or material proposed to be substituted is the equal of any item or material so specified,
2. That the decision of the Engineer on all such questions of equality shall be final; and,
3. That in the event of any adverse decision by the Engineer, no claim of any sort shall be made or allowed against the Engineer or the City.

B. Should the Contractor elect to submit an "or equal" for any specified equipment or material for approval by the Engineer, the Contractor shall be responsible for any modifications which are necessary to make the equipment or material operate or function so as to meet the requirements of the Contract Documents, at no additional costs or expense to the City, including without limitation, costs and expenses arising out of or related to additional testing.

C. If, subsequent to award of the Contract, it becomes necessary or desirable because of the inability of the Contractor to obtain promptly any items, equipment or materials as specified, or because the Contractor intends to use an "or equal" thereof, the Engineer, at his sole discretion, may authorize use of "or equal" or substitute items, equipment or materials of the same, greater, or less cost than those specified. In such cases the Contractor shall submit, in writing, its request for permission to use "or equal" equivalents or make such a substitution and shall furnish full information as to costs of the item, equipment or material specified, and the item, equipment or material to be equaled or substituted therefore. Such information shall be in such form and detail as to permit the Engineer to check to his satisfaction the specifications, quality and costs issues involved with any such request. Prior to the approval of the "or equal" or substitution, when the direct cost thereof is less than the direct costs of the item, equipment or material specified,

the Engineer will issue a written authorization and directive setting forth the appropriate credit(s) to be allowed the City. The credit(s) so authorized by the Engineer shall represent the difference between the net cost to the Contractor of the "or equal" or substituted items, equipment or material, and the price at which it could have obtained the lowest priced item, equipment or material specified. Under no circumstances shall the Contractor be entitled to any increase in the cost or time of performance arising out of or relating to the approval by the Engineer of any "or equal" or substitute item, equipment or material.

D. The decision of the Engineer, from time to time, as to the proper credits to be allowed the City shall be final and conclusive upon the Contractor.

E. The Contract Documents may specify the name of manufacturer, trade name, model number or type of item, equipment or materials to be used in the project. All Bids shall be based on the named items, equipment or materials so specified without exception, and any credit authorized and directed by the Engineer for approval of any "or equal" or substitute item, equipment or material may be calculated on such use in the Contractor's Bid regardless of whether the Contractor did, in fact, base its Bid on the named item, equipment or materials. Reference made to a particular product or model of the manufacturer is made to identify a particular design, quality, construction, arrangement, style, etc.

F. If the Contractor wishes to substitute a product of equal quality and fitness for a named material or item of equipment, it shall submit to the Engineer complete information and Working Drawings for such proposed substitute item, including without limitation all necessary redesign of the structure, partitions, foundations, piping, ductwork, wiring, or of any part of the project needed to accommodate such substitution. This submittal shall accompany the submission of the materials list. All such redesign and all new Drawings and detailing required therefore shall be prepared by the Contractor at the Contractor's sole costs and expense. If substitution of any item requires a different quantity and arrangement of structure, partitions, foundations, piping, ductwork, wiring, conduit and equipment from that specified or indicated on the Contract Drawings, the Contractor shall perform all such changes, modifications or Extra Work required arising out of or relating thereto at no additional cost, expense or time to the City. Requests for increases in the Contract amount or Contract Time to accommodate substitutions shall not be considered by the City, and the Contractor expressly waives any and all claims arising out of or relating thereto. The City shall pursue credits for substitute items of lower cost from the Contractor, and the Contractor shall be responsible for the payment thereof. It shall be expressly understood that equipment and materials named shall be furnished in full accordance with the Contract Drawings and/or Specifications.

G. The attention of the Contractor is especially directed to the requirement that, if the Contractor proposes to substitute materials or equipment as "equals" to those specified, it shall be the Contractor's responsibility to furnish complete, specific, detailed information from the manufacturer or supplier of the material or equipment it proposes to furnish, in which the requirements of the Contract Documents are shown to be met or exceeded within twenty (20) days after Notice to Proceed. This submission by the Contractor shall include, without limitation, a point-by-point comparison of the specification requirements with the material or equipment proposed to be furnished. This comparison will include actual bid day pricing for the "or equal" substitution and specified equipment. In the event the Contract Documents mention a model number and manufacturer, a point-by-point

comparison of the equipment specified under the Contract and the proposed substitute shall be provided. The full burden of responsibility for furnishing this information is with the Contractor. If, in the Engineer's sole discretion, incomplete or irrelevant data is submitted by the Contractor to comply with this requirement, the data shall be returned to the Contractor and the request for approval of the substitution shall be denied. Names of manufacturers for substitute items, which are not approved by the Engineer, shall not be considered and the Contractor shall supply the products named in the Specifications. The Contractor accepts all responsibility for any delays that result from the "or equal" approved process.

01 26 00 CONTRACT MODIFICATION PROCEDURES

01 26 10 ALTERATION OF PLANS AND/OR SPECIFICATIONS

A. The Engineer reserves the right to make such alterations in the Plans and/or the Specifications as may be considered necessary or desirable from time to time to complete fully and perfectly the construction of the project, provided such alterations do not change materially the original intent of the Plans and Specifications. Such alterations shall not be considered as a waiver of any condition of the Contract Documents nor to invalidate any of the terms, conditions and/or provisions thereof.

B. Should such alterations in the Plans and/or the Specifications produce increased costs or result in decreased costs to the Contractor, subject to other terms and conditions of the Contract Documents, a sum equal to but not exceeding the direct costs of any such alteration together with allowable markup in accordance with the Contract Documents shall be agreed upon in writing by the Contractor and the Engineer, before such Work is begun. This cost difference shall be added to or deducted from the Contract Price as the case may be.

C. No allowance or other adjustments in the Contract amount shall be made for loss of anticipated profits by the Contractor on Work omitted.

01 26 13 REQUESTS FOR INFORMATION/INTERPRETATION

A. To properly coordinate and to expedite processing of questions from the Contractor to the City, a "Request for Information/Interpretation" ("RFI") procedure has been established. No construction-related question will be answered unless submitted on the RFI form included in the Contract Documents. Each RFI properly completed and submitted will receive prompt written clarification or interpretations of the Contract ("RFI Response"), with clarification numbers assigned by the City to correspond to RFI numbers.

B. If the Contractor believes that the RFI response given by the City entitles it to an increase in Contract amount or Contract Time the Contractor shall request a proposed Change Order (CO) number from the City within five (5) days of receiving any such RFI response as a condition precedent to any such increase in the Contract amount or Contract Time.

C. A sample RFI form is provided by the Engineer for the Contractor's use. The blank spaces shall be filled in correctly, where indicated, for each and every line. The RFI numbers shall be assigned by the Contractor and be sequentially numbered. For any subsequent RFI pertaining to the same subject, a sub letter of lower case should be used (example – RFI

#56a). Distribution names for the RFI form will be given to the Contractor at the pre-construction conference.

D. Except in cases of emergency not caused, in whole or in part, by the fault or negligence of Contractor, all RFI's shall be submitted by the Contractor to the Engineer sufficiently in advance of the scheduled performance of Work that will or may be affected thereby, but in no event less than twenty-one (21) days prior to the performance of any such Work, so as to permit the Engineer time to study the issue(s) presented therein and issue an RFI response thereon so as to avoid or mitigate the time and/or cost impact that may or would have resulted due to any such RFI's.

01 26 34 ENGINEER MAY INCREASE OR DECREASE QUANTITIES

A. The Engineer reserves the right to increase or decrease the amount or quantity of any item included in the Contract, wherever he deems it advisable or necessary to do so in order to properly complete all the Work to be done under the Contract. Any such increases or decreases shall be conveyed to the Contractor in writing and signed by the Engineer.

B. The Contractor will be paid for the actual amount or quantity of authorized Work done or material furnished under any unit price item of the Contract, at the price Bid and stipulated for such item. In the event the amount or quantity of any item is increased as above provided, the Contractor shall not be entitled to any increased compensation over and above the price Bid for such item. In the event the amount or quantity of any item is decreased as above provided, the Contractor shall not have any claim for damages of any sort, including without limitation, on account of loss of anticipated profits or otherwise because of such reduction.

C. Contingent items may be increased, decreased or eliminated entirely without negotiation. Contingent items may be included in the proposal for the sole purpose of providing for either an increase or decrease in lump sum items where specifically indicated in the Contract Documents.

D. Variation in estimated quantities: Where the quantity of a pay item in a Contract is an estimated quantity and where the actual quantity of such pay items varies more than twenty-five percent (25%) above or below the estimated quantity stated in the Contract, an equitable adjustment in the Contract Price shall be made after receipt of written demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above one-hundred twenty-five percent (125%) or below seventy-five percent (75%) of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the Contractor shall so notify the City, and/or its authorized representative, pursuant to Section 01 32 16 DD; request for time extension, in writing within ten (10) days from the beginning of the delay, otherwise any such time extension shall be deemed to have been permanently and irrevocably waived. The City shall ascertain the facts and make the adjustment for extending the completion date as in their judgment the findings justify.

01 26 37 UNAUTHORIZED WORK

Work performed by or on behalf of the Contractor beyond that required by the Contract Documents and/or any Extra Work performed by the Contractor without prior written authority of the Engineer shall be considered as unauthorized, shall not be measured by the Engineer or paid for by the City, and shall be deemed the sole responsibility of the Contractor. Additionally, the City may require that any unauthorized Work performed by the Contractor be removed at the Contractor's sole cost and expense.

01 26 46 CONSTRUCTION CHANGE ORDERS AND DIRECTIVES

A. Changes shall be authorized or ordered by the Engineer in writing and in advance of performance. The written Change Order shall describe the character of adjustment in the Work including but not necessarily limited to the type of work, construction method, material substitution, the applicable value of work (cost or credit), the appropriate basis of payment and the extension or reduction (if any) of the Contract Time allowed. If obtaining prior approval of the Board of Estimates (when required) shall cause substantial delay in the progress of the Work, or substantial additional costs to the City because of such delay, the Engineer, with the written concurrence of the Director, shall have the authority to order such change without obtaining the prior approval of the Board of Estimates. However, in that event, an early written notification to the Board of Estimates shall state the reasons why it was necessary to order the change without first obtaining approval.

B. For extended general conditions or any other type of Change Orders that result from the City granting the Contractor a compensable time extension, neither the Contractor nor its Subcontractor will be allowed any overhead and profit.

C. For each Change Order issued by the Engineer, which involves cost variation, the Contractor shall submit a proposal, in writing, indicating the appropriate cost or credit (or combination of these), as the case may be, established separately or in combination from Contract Unit Prices, negotiated unit prices, and/or lump sum(s). Included therewith shall be a Contractor's statement proposing the extent to which the authorized Contract Time shall be increased or decreased. Unless an extension of time is specifically stated in the Change Order, no additional time shall thereafter be allowed. The proposal shall also include an itemized breakdown of all lump sum amount(s) prepared in a form consistent with the following provisions.

D. Notwithstanding any other provisions of the Contract Documents, should the Contractor and Engineer fail to agree on the scope, price and/or time related to any actual or purportedly changed or Extra Work, including without limitation, acceptable lump sum amount(s) or negotiated price(s), the Engineer shall have the right to direct that the Work be performed by the Contractor on a time and material basis ("force account") and a correct accounting shall be kept by the Contractor and the Engineer of the cost of all direct labor, material and equipment used for the Force Account Work. Allowances in accordance with the following procedures shall be added to this cost.

1. For Work performed by Contractor's own organization:

    a. The Contractor will be allowed no more than twelve percent (12%) overhead and eight percent (8%) profit, a total of twenty percent (20%), for

its direct labor and material costs. The direct labor cost (hourly or salary), shall be that which is entered on the certified payroll without inclusion of fringe benefits and labor burden. The material costs shall be supported by receipted invoices.

b. The Contractor for use of trucks, machinery or special equipment (other than small tools and small trucks, (three-quarter (3/4) ton or smaller), incidental to the Work), owned and operated by it shall receive rates not to exceed the current "rental rate blue book" rates adjusted for that portion of the State of Maryland that includes Baltimore City. These rates shall be applied for the actual time items are in operation on the Work. These rates shall have been agreed upon, in writing, by the Engineer in advance of the use. Authorized idle time for any such equipment, which is necessary for the Force Account Work and is not used elsewhere on the project, will be paid for at fifty percent (50%) of the monthly rates unless there is a prior written agreement. If so, it shall be fifty percent (50%) of the agreed rates. The estimated operating cost/hour for equipment shall be added to the agreed rates only for periods of actual operations. Operators shall be separately included in the Contractor's direct labor costs. For purpose of definition, equipment with a new cost of five hundred dollars ($500) or less, will be considered small tools.

c. The Contractor for use of trucks, machinery or special equipment (other than small tools and small trucks, (three-quarter (3/4) ton or smaller), incidental to the Work), which may be rented from a bona fide rental firm that is an independent legal entity; shall receive the invoiced cost of rental not to exceed the current "rental rate blue book" rates adjusted for that portion of the State of Maryland that includes Baltimore City, to which an amount equal to eight percent (8%) of those costs exclusive of use tax, will be allowed. These rates shall be applied for the actual time that such items are in operation on the Work. Use tax is to be reimbursed at cost. Unless there is a prior agreement, the invoiced cost shall be taken to include operating costs. The cost of the operator shall be included in the Contractor's direct labor cost.

2. Work Performed by Subcontractors:

a. The Subcontractor will be allowed no more than twelve percent (12%) overhead and eight percent (8%) profit, a total of twenty percent (20%), for its direct labor and material costs. The direct labor cost (hourly or salary), shall be that which is entered on the certified payroll without inclusion of fringe benefits. The material costs shall be supported by receipted invoices.

b. The Subcontractor for use of trucks, machinery or special equipment (other than small tools and small trucks, (three quarter (3/4) ton or smaller), incidental to the Work), owned and operated by it shall receive rates not to exceed the current "rental rate blue book" rates adjusted for that portion of the State of Maryland that includes Baltimore City. These rates shall be applied for the actual time items are in operation on the Work. These rates shall have been agreed upon, in writing, in advance of the use. Authorized idle time for any such equipment, which is necessary for the Force Account Work and is not used elsewhere on the project, will be paid for at fifty percent (50%) of the monthly rates, unless there is a prior written agreement. If so, it shall be fifty percent (50%) of the agreed rates. The

estimated operating cost/hour for equipment shall be added to the agreed rates only for periods of actual operations. Operators shall be separately included in the Subcontractor's direct labor costs. For purpose of definition, equipment with a new cost of five hundred dollars ($500) or less, will be considered small tools.

c. The Subcontractor for use of trucks, machinery or special equipment (other than small tools and small trucks, (three quarter (3/4) ton or smaller), incidental to the Work), which may be rented from a bona fide rental firm that is an independent legal entity; shall receive the invoiced cost of rental not to exceed the current "rental rate blue book" rates adjusted for that portion of the State of Maryland that includes Baltimore City, to which an amount equal to eight percent (8%) of those costs exclusive of use tax, will be allowed. These rates shall be applied for the actual time that such items are in operation on the Work. Unless there is a prior agreement, the invoiced cost shall be taken to include operating costs. The cost of the operator shall be included in the Subcontractor's direct labor cost.

E. The Contractor will be allowed eight percent (8%) of the Subcontractor's costs before allowance for overhead, profit and fringe additives on Subcontractor labor, material and Subcontractor owned equipment at agreed rates.

1. Subcontractors will not be permitted to further subcontract its portion of the Work.
2. Equipment rental rates shall be based on the following:

   a. If time of active use is eight (8) hours or less, rates shall be figured on an hourly basis.
   b. If time of active use is in excess of eight (8) hours, but not over twenty-four (24) hours, rates shall be figured on a daily basis.
   c. If time of active use is in excess of twenty-four (24) hours, but not over one-hundred twenty (120) hours, rates shall be figured on a weekly basis.
   d. If time of active use is in excess of one-hundred twenty (120) hours, rates shall be figured on a monthly basis.

3. Direct labor costs shall include wages paid in accordance with the Contractor's employment practices for all employees actively engaged in the Work. No additional allowance shall be made for Superintendents, as this will be included below. Superintendents shall be considered as those in a supervisory position, over that of a foreman.
4. Allowances for overhead, shall include but not be limited to resident and/or non-actively engaged supervision, timekeepers, clerks, stenographers, security personnel, cost of correspondence, cost and/or use of small tools and trucks, living and travel allowance, maintenance and/or operations of Contractor's regularly established principal office, branch office or other similar facilities.
5. Additional Contractor expenditures reimbursed at cost:

   a. On Extra Work as defined in these Specifications and performed on a lump sum or force account basis, the Contractor will be reimbursed for the actual amount of sales and use taxes, payroll taxes, applicable insurances and all other items pertaining to a collective bargaining agreement chargeable to and paid by the Contractor. No percentage allowance for overhead and profit shall be applicable to such expenditures.

6. The Contractor's representative and the Inspector shall compare records for Force Account Work (time and material) at the end of each day. Copies of the record shall be made in duplication on forms provided by the Engineer and signed by both the Contractor and the Inspector. If the Change Order involves only a deletion, the Contract amount shall be reduced by the amount to which the Contractor would have been entitled if the omitted item, type of Work, construction method or material had not been eliminated.
7. A Change Order issued by the Engineer shall in no manner or extent relieve the Contractor of any of its obligations under the Contract. All Work done under Change Order shall be performed in accordance with provisions of the basic Contract, shall be considered a part of same and shall be subject to each and all the terms and requirements thereof.
8. The overhead and profit allowances outlined are applicable for all base Contract Change Orders; not just time and material Change Orders.

01 26 47 EXTRA WORK A PART OF CONTRACT

No order for Extra Work, nor the doing of any Extra Work, at any time or place shall in any manner of extent relieve the Contractor or the Surety on its Bonds from any of their respective obligations under the Contract Documents and Bonds; all Extra Work orders being given and all Extra Work being done, under, arising out of, relating to, and/or in accordance with the Contract are to be considered a part of the same and subject to each and every one of the terms and requirements of the Contract Documents, and fully covered by the Bonds furnished by the Contractor and its Surety without additional notice or consent of either required to be so bound.

01 29 00 PAYMENT PROCEDURES

01 29 74 MEASUREMENT OF QUANTITIES

For all items of Work, other than those to be paid by lump sum, after the Work is completed and before final payment is made therefore, the Engineer shall make final measurements to determine the quantities of various items of Work performed as the basis for final settlement. The Contractor, in case of unit price items, will be paid for the actual amount of Work performed and for the actual amount of materials in place, in accordance with these Specifications as shown by the final measurements. All Work completed under the Contract shall be measured by the Engineer according to the standards of weight and measures recognized by the National Bureau of Standards.

01 29 75 SCOPE OF PAYMENTS

The Contractor shall receive and accept the compensation, as provided in the Bid or proposal, in full payment for furnishing all materials, labor, tools, equipment and all other items necessary for performing all Work contemplated and embraced under the Contract and for all loss or damage arising out of the nature of the Work and from the action or consequences of the weather, and from any unforeseen difficulties or obstructions that may arise or be encountered during the prosecution of the Work until its final acceptance by the City, and for all risks of every description connected with the prosecution of the

Work, and for all expenses incurred by or in consequence of the suspension or discontinuance of the prosecution of the Work as herein specified, and for any actual or alleged infringement of patent, trademark or copyright, and for completing the Work and the whole thereof in an acceptable manner according to the Plans and Specifications. The payment of any current or final estimate, or of any retained percentage, shall in no way or in no degree prejudice or affect the obligation of the Contractor, at its own cost and expense, to renew or replace any defects and imperfections in the construction of the Work or in the strength of or quality of materials used in or about the construction of the Work under the Contract and its appurtenances, as well as all damage due or attributable to such defects, which defects, imperfections or damages shall be discovered on or before the final inspection and acceptance of the Work, and of which defects, imperfections or damages the Engineer shall be the judge, and the said Contractor shall be liable to the City for failure to do so.

01 29 76 PROGRESS PAYMENT PROCEDURES

A. As long as the Work Contracted for is prosecuted in accordance with the provisions of the Contract, and with such progress as may be satisfactory to the Engineer, the Engineer will, on or about the first day of each month, make an approximate estimate of the proportionate value of the Work done up to and including the last day of the previous month.

B. No payments will be made for materials and equipment stored on the project site or not actually incorporated in the Work except where specifically permitted in the Special Provisions. Where such permission is given for payment for materials and equipment furnished and delivered to the site or bonded warehouse, the estimates of monthly progress of the Work will include the cost of all materials and equipment necessary in the performance of the Contract but not yet incorporated in the Work provided that said materials and equipment shall have been delivered to the site of the Work or delivered to a bonded warehouse designated and approved in advance and in writing by the Engineer and all the other provisions of the Contract Documents relating thereto have been complied with.

C. The Contractor will not be paid for said materials and equipment, as specified in paragraph B above, until it shall have furnished and delivered to the Engineer receipted invoices or properly notarized affidavits, showing the actual cost of said materials and equipment and that this material and/or equipment has been paid for; and the titles to said materials and equipment shall pass upon delivery of the aforesaid receipted invoices or affidavits and remain with the City.

D. The storage of said materials and equipment shall be made in accordance with the direction of the Engineer, and the cost of delivery, storage, maintenance, guarding, protection, handling and transportation, prior to the incorporation of the aforesaid materials and equipment in the Work shall be paid by the Contractor, notwithstanding the title has passed to the City.

E. Any loss or damage by fire, theft, deterioration or any other means or causes, to the materials and equipment delivered and stored as herein provided, shall be borne by and be the sole responsibility of the Contractor and/or the Surety.

F. The Engineer shall have the right, periodically, to inspect and test the said materials and equipment and nothing herein contained shall be construed to limit the right of the Engineer to reject, after such inspection or test, any or all of said materials and equipment so delivered, stored or paid for as provided herein.

G. The Contract value of Work satisfactorily performed during the preceding calendar month will be paid to the Contractor, less ten percent (10%). When such ten percent (10%) retainage amounts to five percent (5%) of the total Contract value, plus authorized extras and additions, in the Engineer's sole discretion no further retainage will be deducted from the monthly payments due the Contractor. The appropriate retained percentage shall be deducted from each and every estimate made under the entire Contract and shall be retained until final completion of all Work covered that may appear in the Contract Documents.

H. Where a lump sum Contract is involved, the Contractor shall submit, for the Engineer's approval, a schedule of payment outlining quantities, items, values, etc., to be used in the calculation of monthly estimates. Where a lump item is included in the proposal for "initial expense" the Contractor shall submit, for the Engineer's approval, a lump sum breakdown outlining quantities, items, values, etc., to be used in the calculations of monthly estimates. Costs incurred by the Contractor, as specified, may be included for payment in full on the first monthly voucher, provided such payment has been approved as outlined above, and provided that receipted invoices, or other acceptable documentation is presented for the Engineer's record as proof of expense incurred.

01 29 77 PAYMENTS MAY BE WITHHELD

Payments may be withheld, at any time, in whole or in part if, in the judgment of the Engineer, the Work is not proceeding in accordance with the Contract Documents, the Contractor is not complying with the requirements of the Contract Documents (including without limitation the Contractor's failure to submit acceptable construction schedules in a timely manner), or when necessary for the Contractor to comply with violations to City regulations when fines are necessary. If the Engineer and the Contractor are unable to reach an agreement on a revised payment amount as a result of any of the foregoing, the Engineer will authorize payment for an amount he determines to be appropriate. The Engineer may also decline all or any portion of a payment as he deems necessary to protect the City against loss, damage or other liability arising out of or relating to defective Work not remedied; third party claims filed or reasonable evidence indicating probable filing of such claims; failure of the Contractor to make payments properly to Subcontractors and suppliers; or reasonable evidence that the Work cannot be completed for the unpaid balance of the then current Contract amount or within the approved Contract time. The Contractor shall not be permitted to stop or suspend prosecuting diligently all or any part of the Work on account of or as a result of any payment or portion thereof being withheld in accordance with this paragraph or any other provision of the Contract Documents, and Contractor shall be solely responsible and liable for any and all direct, indirect and consequential damages arising out of relating to any such stoppages or suspensions of Work.

01 29 78 APPLICATION OF MONIES RETAINED

The City shall be fully authorized to apply the whole or any part of any monies retained to any and all costs of maintenance, repairs, supplementation or re-procurement of Contractor's Work from other Contractors due to Contractor's failure to prosecute same in accordance with the Contract Documents, renewals of the Work and appurtenances which may become necessary in the judgment of the Engineer, at any time or times during the progress of the Work if the Contractor shall fail to do so after receiving notice from the Engineer, or to any and all other items as may be necessary to avoid, defend, or otherwise protect the City and its consultants from and against actual or threatened loss, damage or other liability arising out of or relating to the Contractor's acts or omissions in connection with the Work.

01 29 79 EXTRA WORK CERTIFICATES

All Contractors are advised that any and all information contained in the Extra Work certificates, shall be required to be submitted with payment requests as a condition precedent to the payment of Contractors by the department of finance for such costs and expenses.

01 32 00 CONSTRUCTION PROGRESS DOCUMENTATION

01 32 13 STRIKES

The Contractor shall adjust all strikes, or other labor troubles, directed at its organization and no allowance will be made for such delays in the time limit herein named.

01 32 16 SCHEDULES AND REPORTS

A. The Work shall be planned, scheduled, executed, reported, and accomplished using the critical path method (hereinafter referred to as CPM), in Calendar Days, unless otherwise specifically provided in the Contract Documents.

B. The primary objectives of the CPM scheduling requirements are (1) to insure adequate planning and execution of the Work by Contract; (2) to assist the City in evaluating progress of the Work; (3) to provide for optimum coordination by Contractor of its trades, Subcontractors and suppliers, and of its association to the Work or services provided by a separate Contractor; (4) to permit the timely prediction or detection of events or occurrences which may affect the timely prosecution of the Work; and (5) to provide a mechanism or tool for use by the City and Contractor which may be required through the completion of the various portions of the Work by the specific dates specified in the Contract Documents.

C. Contractor is responsible for determining the sequence of activities, the time estimates of the detailed construction activities, and the means, methods, techniques and procedures to be employed. The construction schedule shall represent the Contractors' best judgment of how it will prosecute the Work in compliance with the Contract requirements. The Contractor shall ensure that the construction schedule is current and accurate, and is

properly and timely monitored, updated, and revised as project conditions and the Contract Documents may require.

D. At minimum, the Contractor shall consult with its principal Subcontractors and suppliers relating to the preparation of its construction plan and construction schedule. All of Contractor's Subcontractors and suppliers shall receive copies of the Contractor's construction schedule specifically noting its respective portions of the Work, and it shall be continually advised of any updates or revisions to the construction schedule as the Work progresses. When the Contractor submits its construction schedule to the Engineer or makes any proposed updates, logic changes or other revisions to such schedule, such submission shall constitute an affirmative representation by the Contractor that it has consulted with and has the concurrence of its Subcontractors and suppliers. Contractor shall be solely responsible for ensuring that all of its Subcontractors and suppliers comply with the requirements of the construction schedule for its respective portions of the Work.

E. The Contractor will provide the basic data relating to activities, durations, and sequences to the Engineer as part of the Contractor's draft of the construction schedule. This data shall reflect the Contractor's actual construction plan for the project, and shall fully comply with all requirements of the Contract Documents.

F. When there are separate Contractors working concurrently on the project whose Work must interface or be coordinated with the Work of the Contractor, the Contractor shall coordinate its activities with the activities of the separate Contractors at no additional cost or expense to the City, and Contractor shall, prior to submission of its construction schedule to the Engineer and thereafter when any changes are made thereto, obtain written approval of its construction schedule by each such separate Contractor. If the Contractor is unable to obtain such written approval by the separate Contractors, the Engineer or his designee shall make a determination of the schedule, which shall be binding upon the Contractor and the separate Contractors.

G. To carry out the intent of the section, the Contractor agrees that the preconstruction meeting, as described in 01 11 14, provision of drafting and computerization services by City, and the reasonable exercise of any rights under this section by the Engineer, shall not be grounds for any claims by the Contractor or any of its Subcontractors for alleged interference, lack of cooperation, delay, disruption, impact, negligence or hindrance by the City or any of its personnel, consultants, program managers, or otherwise, and the Contractor covenants not to sue any thereof.

H. It is understood and agreed that the construction schedule is to represent the Contractor's best plan and estimate for the Work. However, the Contractor acknowledges that the construction schedule may have to be revised from time-to-time as progress proceeds. The Contractor further acknowledges and agrees that the City, by approving any such schedule, does not guarantee, warrant or otherwise represent or imply that: (1) the Contractor can start Work activities on the early start or late start dates or complete Work activities on the early finish or late finish dates shown in the schedule, or as same may be updated or revised; (2) the Contractor can proceed at all times in the sequence established by the utilization of only the resources and manpower it initially plans for the performance of the Work; (3) the Contractor's construction schedule will not have to be modified in order to obtain the agreement of any separate Contractors' schedules; or (4) the Contractor's construction schedule shall be in full compliance with all requirements of the Contract Documents.

I. The Contractor acknowledges and agrees that its construction schedule must be flexible in order to accommodate and allow for its coordination with the operations of the City and the Work of separate Contractors relating to the project. The Engineer will review the Contractor's construction schedule for compatibility with City operations and the Work of separate Contractors to resolve any conflicts between the Contractor's construction schedule and the operations of the City or Work of separate Contractors. The Contractor agrees to fully cooperate with City and separate Contractors to resolve such conflicts and to revise its construction schedule as reasonably required.

J. In order to maintain the orderly progress of the Work performed on the project, the Engineer and the City shall have the right to determine the priority between the Work performed by the Contractor and the Work of any separate Contractors or City's operations. This decision shall be final and binding upon the Contractor and shall not be a cause of extra compensation or an extension of time, except where an extension of time is granted because of a delay for which the Contractor is otherwise entitled to an extension under the Contract Documents. Provided, however, that this right shall not be exercised by the City unless; (1) the determination is necessary because of project conditions; and (2) the Contractor and any separate Contractor cannot otherwise agree upon such priority of schedule construed as relieving the Contractor of its obligation to cooperate with any separate Contractors on the project.

K. If the Contractor's construction schedule indicates that the City is to complete an activity or perform certain preceding Work by a particular date, or within a certain duration, the City, or any separate Contractor shall not be bound to said date or duration unless the City expressly and specifically agrees in writing to same. The review, approval or acceptance by the City or the City's Design, Inspection or program management consultants of the construction schedule, updates or revisions thereto, or any other schedule or plan of construction of the Contractor, does not constitute and shall not be construed as direct or implied agreement by the City or any of its aforementioned consultants of any start or finish date in the schedule, logic ties, or specific durations or sequences for activities of the City, the Contractor or any separate Contractor; provided, however, that nothing herein shall be construed as modifying or changing, or excusing the performance of the Contractor of required portions of the Work by the specific dates as set forth in the Contract Documents.

L. Approval or acceptance by the City or any of its consultants of the Contractor's construction schedule, or any revisions or updates thereto, is advisory only and shall not relieve the Contractor of the responsibility for accomplishing each portion of the Work within each and every applicable specific date. Omissions and errors in the approved or accepted construction schedule, or any revisions or updates thereto shall not excuse non-compliant performance. Approval of any such schedules by the City or its consultants in no way makes the City an insurer of the reliability, accuracy or feasibility of the construction schedule, nor liable for any direct or indirect time or cost overruns flowing from such omissions or errors. It is understood and agreed that the Contractor cannot rely and shall not rely or make any claim based upon any informal or constructive acquiescence or approval of the construction schedule or any update or other revision thereof by the City or its consultants. No individual or entity has any right or power to agree to any schedule commitment or obligation on behalf of the City except as set forth expressly in the Contract Documents.

M. Should the Contractor intend or plan to complete the Work, or any portion thereof, earlier than applicable specific dates or the Contract time, the Contractor shall give timely and reasonable notice of the fact to the Engineer and provide reasonable resource (crew sizes, hours, shifts, etc.), equipment, material, production rates, coordination with and agreement by separate Contractors and Contractor's Subcontractors and suppliers, and the volume and nature of other Work then in progress by Contractor to substantiate the Contractor's plan. The City shall have the sole discretion to agree to or reject such early completion plan by the Contractor. Under no circumstances shall the City have any implied or direct duty or obligation to agree to, or to cooperate with the Contractor regarding an early completion plan or proposal, all such implied and direct duty or obligation being expressly disclaimed. Likewise, under no circumstances shall the City be liable to the Contractor for any direct or indirect damages arising out of or relating to the approval or rejection of any such early completion plan by the Contractor and shall not be liable for any damages of the Contractor because of the rejection by the City of said plan. The intention of this paragraph is to discourage the use of early completion plans or schedules and for the Contractor's Work activities to be spread across the entire Contract Time.

N. Unless otherwise specifically provided in the Contract Documents, the Contractor acknowledges that the City has contemplated in its planning and initial scheduling of the project and budgeting for professional services that the Work will be performed on a five (5) day work week basis, utilizing a single eight (8) hour shift per day. The City shall have the sole discretion of approving or rejecting a variance in the work week, number of shifts, or shift length. Unless agreed to by the City, in writing, the Contractor shall bear the cost of, and pay the City, for additional staff and supervisory personnel necessary to support any variance in the contemplated work week, number of shifts or shift length.

O. Among other things, the Engineer will review the objectives of the schedules and report requirements; the procedures and requirements for the preparation of the construction schedules and schedule of values by the Contractor; how the requirements of the Contract Documents will be monitored and enforced by the Engineer; and long lead items and time requirements for Work by Subcontractor will be identified. Within fifteen (15) days of the orientation session (even though the Contractor may not have completed subcontract negotiations and executed subcontracts), the Contractor shall complete and submit a draft of its critical path method schedule.

P. Except for procurement requirements, the Contractor shall differentiate activities of the schedule so that no single activity shown has a duration longer than fourteen (14) calendar days, unless the Engineer, at his sole discretion, shall approve a longer duration for certain activities.

Q. The construction schedule shall represent the Contractor's best judgment and intended plan for completion of the Work in compliance with specific dates listed in the Contract Documents and shall take into account all foreseeable activities to be accomplished by any separate Contractors, and interface dates with utility owners, the City's operations and others. The construction schedule shall anticipate all necessary manpower, equipment, materials and other resources to accomplish the activities within the durations set forth in the construction schedule.

R. The Engineer shall have the right to require the Contractor to modify any portion of the Contractor's construction schedule, schedule of values or recovery schedule as herein required, with the Contractor bearing the expense thereof, which the Engineer reasonably determines to be: (1) impracticable; (2) based upon erroneous calculations or estimates;

(3) unreasonable; (4) required in order to ensure proper coordination by the Contractor of the Work of its Subcontractor and with the Work or services being provided by any separate Contractors; (5) necessary to avoid undue interference with the City's operations or those of any utility owners or adjoining property owners; (6) necessary to ensure completion of the Work by the specific dates with the requirements of the Contract Documents; (7) required in order for the Contractor to comply with the requirements of the Contract Documents; or (8) not in accordance with the Contractor's actual operations. The Engineer will be available during normal working hours to consult with the Contractor should questions arise while the Contractor assembles the information required for the construction schedule.

S. The Contractor shall submit a completed draft of each required schedule submission, including without limitation, all updates and other revisions or modifications thereto, to the Engineer on workable, unlocked/unrestricted computer media (such as a CD containing unlocked/unrestricted .prx files with all calendars and logs open for review, but NOT in .pdf, .tif, .jpeg or other imaging format) so as to permit the Engineer full and complete access to activity relationships, activity calendars, activity log files, activity resources and activity costs for his review and comment. Thereupon, the reviewed comments will be forwarded to the Contractor for incorporation into the schedule. Once such comments are incorporated into the schedule, a revised schedule shall be submitted to the Engineer on computer media.

T. CONSTRUCTION SCHEDULE

1. The Contractor shall prepare and submit a detailed schedule entitled "Contract Schedule – First 90 Days" setting forth the sequences and durations of all Work to be performed during the first ninety (90) Calendar Days by the Contractor, Subcontractors, suppliers, and all other agents for the Contractor. The detailed schedule shall commence at the initial Contract milestone, Notice to Proceed (NTP) and must include, without limitation, detailed schedule representations and logical sequences of activities required. This shall serve as the official Contract schedule until such time as the project schedule is submitted and approved.
2. The Contractor shall submit, as a part of the data submitted to the Engineer, a narrative report indicating anticipated allocation by the Contractor of the following resources and work shifts for each activity which it proposes to be utilized on the project:

    a. Labor resources.
    b. Equipment resources.
    c. Whether the Contractor proposes the Work to be performed on single, double or triple shifts, and whether it is to be done on a five (5), six (6) or seven (7) day work week basis.

U. SCHEDULE OF VALUES

1. Each activity on the Contractor's schedule shall have an apportioned activity cost assigned based on the schedule of values.

2. The activity cost for the schedule of values shall be coded with a bid item number and a cost code corresponding to the trade, Subcontractor or supplier performing the Work so that subtotals for each division of the Work can be prepared.
3. The schedule of values shall, in the best judgment of the Contractor, represent a fair, reasonable and equitable dollar (cost) allocation for each activity on the construction schedule. The amounts shall not be unbalanced.
4. The estimated cost to perform each Work activity shall be noted graphically on each activity included in the schedule network. The sum of the costs so assigned shall equal the Contract value. No activity costs are to be assigned to manufacture or delivery schedules.
5. Using the cost assigned to each activity of the detailed network program, the Contractor shall develop a cash flow analysis in graphic form depicting estimated cash draw down in aggregate, by month, over the life of the project. The cash flow projections shall be updated each month to show a forecast of remaining payments to date.
6. The Contractor will provide, after approval of the schedule of values, a computer listing of all cost-loaded activities for Engineer's review.
7. The Contractor's payment applications shall be tied to then current and approved CPM schedule earned values as a condition precedent to payment thereof.

V. CONSTRUCTION SCHEDULE CONTENT

1. The construction schedule shall consist of a critical path method (CPM) schedule of all activities, which are part of the Contractor's construction plan, and accompanying computerized mathematical analysis of these activities. The CPM shall include, but not be limited to, the following information:

    a. Project Name:

        1) Activities of completed Work ready for use by next trade, City, etc.
        2) Activities relating to different areas of responsibility, such as Subcontractor Work, is directly separate from that being done by the Contractor directly;
        3) Different categories of Work as distinguished by equipment requirements;
        4) Different categories of Work as distinguished by materials;
        5) Distinct and identifiable activity coding for subdivisions of Work such as structural slabs, beams, columns;
        6) Locations of Work within the project that necessitate different times or crews to perform;
        7) Outage schedules for existing utility services that will be interrupted during the performance of the Work;
        8) Acquisition and installation of equipment and materials, supplied and/or installed by the City or separate Contractors.

    b. Specific Dates:

        1) For all major equipment and materials to be fabricated or supplied for the project, the construction schedule shall show a sequence of activities including:

2) Preparation of shop drawings and sample submissions;
3) A reasonable time for review of shop drawings and samples or such time as specified in the Contract Documents;
4) Shop fabrication, delivery, and storage;
5) Erection or installation; and
6) Testing of equipment and materials.
7) The construction schedule shall include late completion dates for Work that is no later than the required specific dates. The CPM shall be drawn based upon the early start dates of activities shown on the CPM.

   a) All activity duration shall be given in Calendar Days.

8) The activities shall be coded to allow sorting by area, responsibility, and specification section.

c. Mathematical Analysis: Calculate the CPM schedule based on network logic and activity durations, using calendar dates and identifying for each activity the following:

1) Preceding and succeeding event numbers
2) Activity description
3) Earliest start date
4) Earliest finish date
5) Actual start date
6) Actual finish date
7) Latest start date
8) Latest finish date
9) Total and free float
10) Monetary value of activity, keyed to schedule of values
11) Percentage of activity completed and remaining duration of activity
12) Identify each activity with applicable specification section number
13) Contractor's earnings based on reported portion of activity completed.

d. Computer Outputs: Required as part of initial schedule submission and each submission thereafter throughout the duration of the Project. The first 3 outputs identified below shall include ALL project activities:

1) Activity sort by event number from lowest to highest.
2) Activity sort by early start date and for same early start dates from lowest to highest event number.
3) Activity sort by amount of float and for equal amounts of float from lowest to highest event number.
4) Contractor's periodic payment request sorted in same man.
5) Schedule of values listings.

W. CONTRACTOR APPROVAL AND CERTIFICATION

Approval by the Contractor of the drafting and computerization of the construction schedules and the schedule of values shall be signified by the Contractor by signing the following certification:

"The undersigned Contractor certifies that the construction schedule which is comprised of the CPM displayed on the dated reports dated _____ and of the computerized mathematical reports dated _____ is the Contractor's construction schedule as required by the Contract Document; and that said schedule is a true and accurate representation of its plan of construction of its Work and fully complies with all the requirements of the Contract Documents. The Contractor further certifies that it will prosecute the Work in accordance with this schedule, subject to any change therein which is implemented in accordance with the Contract Documents; and the undersigned acknowledges that this schedule shall be the instrument by which progress of the Work shall be monitored, and together with the dollar value assigned to each activity, shall be the basis of monthly payments in accordance with the Contract Documents; and the Contractor certifies that it has fully complied with all of the requirements of the Contract Documents relating to coordination of said schedule with separate Contractors."

X. UPDATING OF CONSTRUCTION SCHEDULE/PROGRESS REPORTS

1. On or about the dates specified, but no less than monthly, the Contractor shall arrange for its project manager, superintendent, and its authorized schedule representative(s) to meet at the project site with the Engineer to review and discuss the Contractor's written report and analysis of actual progress as prepared by or on behalf of the Contractor. Said report shall set forth up-to-date and accurate progress data, shall be based upon the Contractor's best judgment and shall be prepared by the Contractor in consultation with all principal Subcontractors and suppliers.
2. The progress report and analysis of the Contractor shall show the activities or portions of activities completed during the report period, the actual start and finish dates for all such activities, remaining durations and/or estimated completion dates for activities currently in progress, and such other items and information in a form acceptable to the Engineer.
3. The Contractor shall submit to the Engineer a written, narrative report with the updated progress analysis which shall include, but not be limited to, a description of problem areas, current and anticipated delay or disruption factors and their respective actual or anticipated impact and the Contractor's explanation of the causes thereof, explanations or corrective actions taken or planned, any newly planned activities or changes in activity sequence, duration or logic ties, proposed logic for any recovery schedule, if required, as further described herein. The report shall also include, without limitation, the following:

    a. A narrative describing actual Work accomplished during the reporting period;
    b. A list of major Construction equipment used on the Work during the reporting period and any Construction equipment idle during the reporting period;
    c. The total number of men by craft actually engaged in the Work during the reporting period, with such total stated separately as to office, supervisory, and field personnel;

d. A manpower and equipment forecast for the succeeding thirty (30) days, stating total number of men by craft, and separately stating such total as to office, supervisory and field personnel;
e. A list of Contractor supplied materials and equipment, indicating current availability and anticipated job site delivery dates;
f. Changes or additions to Contractor's supervisory personnel since the preceding progress report.

4. The Contractor will provide initial computer reports and monthly reports thereafter, in accordance with the following:

a. Schedule reports: Initial and subsequent schedule reports will contain the following minimum information for each activity:

(1) Activity number, description and estimated duration in days;
(2) Early and late start and finish dates;
(3) Percentage of each activity completed as of each report;
(4) Remaining float days behind schedule.

b. Responsibility for activity: Actual start and finish dates shall be indicated for each activity, as appropriate. Completed activities will be omitted from remaining float and late start sorts.
c. Cost reports: Initial and subsequent cost reports will include the following information for each activity:

(1) Activity number and description;
(2) Percentage of value of Work in place against total value;
(3) Total cost of each activity;
(4) Value of Work in place since last report;
(5) Value of Work in place to date; and of uncompleted Work.

5. As part of the updating process, based upon progress data provided by the Contractor and agreed to by Engineering, the value of Work done for each activity less the amount previously paid for past percentages completed. Summation of all values of each activity, less the appropriate percent of retainage, shall be the amount payable to the Contractor, provided the Contractor has complied with all requirements of the Contract Documents.
6. As the Contractor is directed to proceed on Change Orders, they shall be entered on the schedule whether or not the cost has been approved. Constraints on the schedule, if any, will be reflected in the CPM network logic. A separate series of activities will be reserved for Change Orders.
7. The Contractor shall be solely responsible for expediting the delivery of any material or equipment to be furnished by the Contractor if it will be later than the delivery date indicated by the construction schedule so that the progress of construction shall be maintained according to the currently approved Construction schedule for the Work.
8. The Contractor shall ensure that the critical path of Work runs through realistic on-site activities, and that off-site activities and unrealistic activities do not and shall

not control the critical path of the construction schedule or the actual performance of Work.

Y. INITIAL PROGRESS PAYMENT

The completed current construction schedule, including the schedule of values, shall be required for each application for payment. However, one (1) initial provisional progress payment may be payable at the sole discretion of the Engineer if he determines that the Contractor is complying with the preliminary schedules and reports provisions during the development of the construction schedule and schedule of values as required herein. However, no more than one (1) application for payment shall be approved until all of the requirements of these schedules and reports provisions have been met.

Z. RECOVERY SCHEDULE

1. Should the updated construction schedule show at any time during the Contractor's performance, in the sole opinion of the Engineer, that the Contractor is fourteen (14) or more days behind schedule for any specific date, the Contractor shall prepare a recovery schedule at no additional cost to the City (unless the City is solely responsible for the event or occurrence which directly caused the schedule slippage without any fault of Contractor in whole or in part) sufficiently explaining, detailing and displaying to the Engineer's satisfaction how the Contractor intends to reschedule its Work in order to regain compliance with the most current approved construction schedule.
2. The Contractor may believe that all of the time can be recovered during the schedule as set forth below. However, if the Contractor believes it will take more than thirty (30) days to recover all of the lost time, it shall prepare and submit a request for revision to the construction schedule and comply with all of the requirements for a schedule revision.
3. The Contractor shall prepare and submit to the Engineer a recovery schedule incorporating best available information from Subcontractors and others that will permit return to the most current approved construction schedule at the earliest possible time within two (2) days of any such request by the Engineer. The Contractor shall prepare a recovery schedule to the same level of detail as the Construction schedule. This recovery schedule shall be prepared in coordination and agreement with the Contractor's Subcontractors and suppliers and other separate Contractors on the project.
4. Within two (2) days after submission of the recovery schedule to the Engineer, the Contractor shall participate in a conference with the Engineer to review and evaluate the recovery schedule. Within two (2) days of the conference; the Contractor shall submit the revisions necessary for the Engineer's review and approval. The Contractor shall use the approved recovery schedule as its plan for returning to the original construction schedule.
5. The Contractor shall confer continuously with the Engineer to assess the effectiveness of the recovery schedule. As a result of this conference, the Engineer will direct the Contractor as follows:

    a. If the Engineer determines the Contractor is still behind schedule, the revisions as stated herein and the other requirements of the Contract Documents provided shall not limit in any way the rights and remedies of the City as provided elsewhere in the Contract Documents.

b. If the Engineer determines the Contractor has successfully complied with provisions of the recovery schedule, the Engineer will direct the Contractor to return to the use of the approved Construction schedule.

AA. SCHEDULE REVISIONS

1. Should the Contractor desire, or otherwise be required under the Contract Documents, to make modifications or changes in its method of operation, its sequence of Work activities or logic ties, or the durations of the activities in its Construction schedule, it shall do so in accordance with the requirements of the Contract Documents. The Engineer must approve revisions to the approved Construction schedule in writing.
2. The Contractor shall submit written requests for any schedule revisions to the Engineer, together with written rationale for revisions and description of logic for rescheduling Work and maintaining the specific dates listed in the Contract Documents. Proposed revisions acceptable to the Engineer and the City will be incorporated into the next update of the Construction schedule. The Contractor shall pay the City for costs incurred for the revisions.
3. If there are separate Contractors on the project, prior to the submission by the Contractor of its proposed schedule revisions, it shall meet with and gain written approval of the separate Contractors to make the revisions which shall be evidenced by the signature of said separate Contractors on the proposed schedule revisions. If accepted by the Engineer and the City, the revisions shall be binding upon the Contractor and all separate Contractors on the project.
4. In submitting any proposed schedule revision to the Engineer, the Contractor shall submit therewith the following certification:

The undersigned Contractor certifies that the proposed schedule revision to the construction schedule which is comprised of its critical path method, dated _____ and of the computerized mathematical reports dated _____ is the Contractor's schedule as required by the Contract Documents; and that said schedule is a true and accurate representation of its plan to complete the Work, including all Change Orders that are in the Contractor's possession as of the foregoing date and fully complies with the requirements of the Contract Documents. The Contractor further certifies that it will prosecute the Work in accordance with this schedule revision, subject to any change therein which is implemented in accordance with the Contract Documents; and the undersigned certifies that it has met, coordinated with and obtained the approval of said schedule revision by all separate Contractors, as evidenced by their respective signatures thereon; and the Contractor further certifies that it has fully complied with all of the requirements of the Contract Documents relating to coordination of said schedule with separate Contractors.

BB. FLOAT TIME

1. Float or slack time associated with one (1) chain of activities is defined as the amount of time between earliest start date and latest start date or between earliest finish date and latest finish date for such activities, as calculated as part of the Construction schedule. Float or slack time shown on the Construction schedule is not for exclusive use or benefit of either the City or the Contractor and is available for use by either of them according to whichever first needs the use or benefits of the float to facilitate the effective use of available resources and to minimize the

impact of project problems, delays, disruptions, impacts or changes in the Work which may arise during performance. The Contractor specifically agrees that float time may be used by the City in conjunction with the City's review activities or to resolve for any modification of the specific dates or an extension of the Contract Time, or a claim for additional compensation as a result of any project problem, Change Order, disruption or delay which only results in the loss of available positive float on the Construction schedule.

2. Float time shown on the Construction schedule shall not be used arbitrarily by the Contractor in a manner, which, in the opinion of the Engineer, unnecessarily delays separate Contractors from proceeding with their respective Work in a way which is detrimental to the interest of the City. If the Contractor refuses to perform Work which is available and necessary to be performed, in order not to delay any separate Contractor, the City may, regardless of the float shown on the Construction schedule to be available for the path of activities which encompasses said Work, terminate the Contractor for default pursuant to the terms of the Contract Documents.

CC. CONTRACTOR'S ORGANIZATION

The Contractor shall designate an authorized representative or representatives in or on behalf of its firm who will be responsible for assisting in the preparation of the CPM schedule and review/report progress of the project with the Engineer's representative. The Contractor's representative(s) shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling requirements of this Section 01 32 16 of the Specifications and such authority will not be interrupted throughout the duration of the project. The person(s) so designated and authorized by the Contractor shall use Primavera CPM scheduling software P3 or P3e/c or higher for developing, monitoring, updating, revising logic diagrams, and analyzing construction schedules, and shall have a minimum five (5) years in using and monitoring CPM schedules with the required software on comparable projects.

DD. REQUESTS FOR TIME EXTENSION

1. In the event that the Contractor requests an extension of the Contract Time, or any interim milestone date applicable thereto, the Contractor shall furnish the following for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the applicable Contract Documents: (a) justification of delay; (b) project schedule data; (c) and such additional supporting evidence as the City and/or any authorized representative, agent or consultant of the City (collectively referred to as the "City") may deem necessary. Submission of proof of delay, based on revised activity logic, durations, and costs (all updated to the specific date that the delay is represented to have started) is a condition precedent to any acceptance or approval of all or any part of the alleged delay and any costs and expenses arising out of or relating thereto. Contractor shall take appropriate steps to guarantee that the provisions of this section are expressly incorporated into all subcontracts and purchase orders relating in any way to the performance of Work.

2. Justification for delay. The project schedules shall clearly display that the Contractor has used, in full, all of the float time available to the Contract completion date or any interim milestone date for the Work involved with its time extension request. The City's determination as to the number of allowable days of Contract time extension shall be based upon the approved project schedule updates in

effect for the time period in question and by other factual information. Actual delays that are found to have occurred for reasons within the Contractor's fault or control that result in the extension of the Contract Time shall not be a cause for a time extension to the Contract Time.

3. Submission requirements. The Contractor shall submit a written justification for each request for a change in the Contract completion date, or any interim milestone date, based upon the most recent schedule update as of the date of issuance of a Notice-to-Proceed for changed Work, or within ten (10) days of the date of the constructive direction or initial occurrence of the event upon which the Contractor relies in support of the time extension request, whichever first occurs. The Contractor's time extension request shall be in accordance with the requirements of other applicable Contract clauses, and shall include as a minimum, the following:

   a. A list of affected critical path activities with their respective associated project schedule activity numbers, and identification of the specific workdays upon which each such activity was so affected and reasons therefore.
   b. A factual narrative of the causes of the change together with all documents upon which the Contractor relies in support of the facts asserted.
   c. An analysis of the overall impact of the changes proposed in both hard copy and electronic format ("electronic format" is defined herein to be unlocked Primavera® data files such that all schedule data including, but not limited to, logic ties, activity durations, logs and calendars are fully accessible to the City). The analysis shall demonstrate the influence of each change or other delay on the then current project schedule completion dates. Each such analysis shall include a fragnet (network analysis) demonstrating how the Contractor proposes to incorporate the Change Order or other delay into the detailed network project schedule. The analysis shall demonstrate the time impact based on the date the change or other delay is given to or first experienced by the Contractor, whichever comes first, the status of construction at such a point in time, and the event time computation of all affected activities. The event times used in the analysis shall be those included in the most current update of the detailed network project schedule, or as adjusted by mutual agreement. The analysis shall also reflect the scope and result of all measures the Contractor took and/or intends to take to mitigate the effect and impact of the change or other delay.
   d. A sub-network, or fragnet, of the affected area and activities in both hard copy and electronic format, as set forth above. The estimated resources and costs to perform each Work activity shall be noted and included in the fragnet.
   e. Activities impacted in each justification for change shall be identified by a unique identification code or unique activity code contained in the required data file.
   f. An interim schedule update with revised activities in both hard copy and electronic format, as set forth above.

4. Notwithstanding anything to the contrary contained in this or any other portion of the applicable Contract Documents, no revisions to the project schedule shall be made by the Contractor absent written approval thereof by the City. Until such time as the City has formally approved in writing all or any part of the Contractor's

Time extension requests, the project schedule shall continue to be updated by the Contractor without inclusion of the requested time extension or any other changes or modifications relating thereto.

5. The Contractor shall supplement its time impact analysis with any additional documents or other information requested by the City, and shall give the City reasonable and timely access to its project files so the City can satisfy itself that all relevant documentation in connection with the time impact analysis has been made available for review. The Contractor shall also make its project personnel available to be interviewed by the City within one (1) business day of receiving a written request from the City for such interviews.
6. Time extensions will be granted only to the extent that the Contractor's fragnet analysis reasonably demonstrates that the change and/or other delay has extended the project completion dates, including without limitation any applicable interim milestone dates, for reasons beyond the Contractor's fault or control in whole or in part.
7. If the Contractor does not submit a proper, fully documented request for time extension, in triplicate, within the time required herein, the Contractor shall be deemed to have irrevocably waived and forever discharged its rights against the City to any additional time and costs arising out of or relating in any way to the facts and circumstances upon which the purported delay or other impact is based. Approval or rejection of each request for time extension by the City shall be made within fifteen (15) business days after receipt of each time impact analysis unless the City, in their sole discretion, deems subsequent meetings and negotiations necessary. If approved by the City, fragnets illustrating the influence of Change Order Work or other delays together with extended project completion dates will be incorporated into the detailed network project schedule during the first update after the City's written approval is received by the Contractor.

01 32 23 SURVEYS AND LEVELS

The Contractor shall employ and pay for the services of a competent registered professional engineer and/or registered land surveyor, as the need may be, to be approved by the Engineer, who shall furnish all lines and grades required by these Specifications, tests and levels of general excavation, footings, base plates, columns, walls, floor and roof lines, roadways, Limit of Disturbance, sidewalks and elsewhere where required by the Contract Documents and/or the Engineer as the Work progresses with certificates that each of the said surveys, levels, and other such information is as required by the Contract Documents. The plumb lines of walls, etc., shall be tested by the Contractor's engineer and/or surveyor as the Work progresses and duly reported to the Engineer.

01 32 27 DAILY CONSTRUCTION LOG

The Contractor or its authorized representative will be required to review and sign the Daily Construction Log prepared by the Resident Inspector. In the event that the Contractor takes exception to any information contained on the Daily Construction Log, it must note the exception on the log prior to signing or any such exception shall be deemed waived.

01 32 33 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide the services of a professional photographer, approved by the Engineer, to take photographs as detailed under these Specifications. The name and address of the proposed photographer shall be submitted at the preconstruction meeting. The photographer will be required to take preconstruction photographs of the site prior to the commencement of Work, progress photographs at approximately one month (1) intervals, and post-construction photographs. The photographer's visits to the site shall be coordinated by the Contractor in advance with the Engineer who will direct the manner, method and units of construction to be photographed.

B. Contractor shall submit to the Engineer, photographs taken to record the existing conditions of all properties and all adjacent properties, as well as the condition of the public right-of-way adjacent to the project site. On or about every thirty (30) days, photographs shall be taken showing the general conditions of the Work and as necessary to portray the construction sequence as viewed from the north, south, east and west elevations. Photographs (one (1) roll of 35mm color prints, minimum of twenty (20), three-inch by five-inch (3" X 5") standard prints and negatives shall be developed and printed and submitted within seventy-two (72) hours of the time they were taken.

C. The Contractor shall submit two (2) prints and the negative of each exposure within seventy-two (72) hours of exposure date. Prints shall be enclosed in one-half inch by eleven inch (8.5″ X 11″) double-faced, clear plastic sleeves punched to fit standard three ring binders. Each set of pre-construction prints shall be submitted in two-inch (2″) capacity, three ring, heavy-duty binders. Two (2) additional binders (of identical type and color originally submitted) shall be provided by the Contractor for every one hundred (100) photographs taken. Labels on binders' covers shall identify: (1) City of Baltimore, (2) location of project, (3) Contract number and title, (4) Contractor's name, (5) photographer's name and (6) Contract start Work date.

D. Identify each image listing with the following:

1. City of Baltimore
2. Location of project
3. Contract number and title
4. Sequential photo number
5. Contractor's name
6. View and description indicating location of camera and direction of shot by compass point or interior orientation, and specific subject of photograph
7. Date picture was taken
8. Name of photographer; and
9. Name of City witnesses.

E. Additionally, submit digital copies on CD's or other digital media as required by the Engineer. They shall show, inasmuch as practicable, Work accomplished during the previous month. Photographic quality and composition of photocopies shall be such that they can be used for briefings and/or to illustrate articles on the construction progress of the project.

F. All photographic work shall be of professional quality with optimum contrast and brightness and in sharp focus. The City shall reserve the right to reject any photographic work that does not clearly define the desired objective. Any photographic work so rejected shall be

cause for requiring the photographer to revisit the site and re-photograph the intended objective at no additional cost to the City.

G. Within two (2) weeks following the preconstruction meeting, the Contractor shall submit the preconstruction photographs to the City for written approval. Notice to Proceed will not be issued by the City to the Contractor until the pre-construction photographs are approved.

H. A photograph shall be defined as one (1) exposure resulting in two (2) acceptable prints and the corresponding negative.

01 33 00 SUBMITTAL PROCEDURES

01 33 10 MANUFACTURER'S LIST

A. Within thirty (30) days after receipt of a Notice to Proceed, and before ordering any equipment or materials, the Contractor shall submit to the Engineer for written approval a complete list of proposed manufacturers and fabricators for all materials and equipment to be used.

B. The purpose of this submittal is to allow the City and Engineer to predetermine the acceptability of proposed suppliers before issuance of purchase orders by the Contractor. Submission and acceptance of the manufacturer's list shall neither relieve the Contractor from submitting detailed shop drawings and product data for all materials and equipment nor shall it constitute prior acceptance of any specific item or equipment prior to submittal of shop drawings. After submission and acceptance of the manufacturer's list, the Contractor shall not deviate from the named suppliers and manufacturers without written approval from the Engineer.

01 33 21 CONTRACT DOCUMENTS, WORKING DRAWINGS, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

A. Shop drawings and product data are generally defined as all Drawings, diagrams, illustrations, brochures, schedules, bills of materials and other data which are prepared by the Contractor, its Subcontractors, suppliers or distributors, or equipment manufacturers and fabricators, which illustrate the manufacturer, fabrication, Construction, installation of the Work or a portion thereof. Shop drawings and product data are required and shall be submitted for every element of the Work, including but not limited to mechanical equipment, piping arrangements, structural steel, reinforcing steel, miscellaneous metals, electrical equipment, and other items as required in the Special Provisions. If the Contractor proposes to deviate from any detail indicated on the Drawings, it shall submit detailed Drawings and descriptions of this Work for approval.

B. Shop drawings submitted by the Contractor shall be twenty-four inches by thirty-six inches (24″ X 36″), shall have three quarter inch (.75″) borders on top, bottom and right-hand side and a one and one-quarter inch (1.25″) border on the left-hand side.

C. Product data, including materials reproduced from manufacturer's product catalogs, shall be no larger than eight and one-half inches by eleven inches (8.5″ X 11″). Catalog data shall be explicit with regard to details of the products being furnished and complete enough to

enable the Engineer to determine that the products submitted conform to the requirements of the Specifications. If a submittal indicates more than one style, size, capacity, etc. of a product on a sheet, the Contractor shall clearly indicate by "highlighting" or otherwise specifically marking exactly which product type is being submitted for approval. Failure to indicate exactly which product is being submitted shall be cause for rejection of the submittal. Catalog data shall bear the name of the manufacturer of the product.

D. The Contractor shall submit Drawings and product data certified correct for Construction for the approval of the Engineer as soon as possible after written approval of the materials list prepared by the Contractor and with due regard to the sequence in which such information will be required for construction. It is the Contractor's responsibility to provide finished Drawings for approval, based on field measurements of actual conditions, indicating how it proposes to install the Work, and the materials and equipment being furnished. Single line Drawings will not be acceptable. Copies of the plans will not be accepted for submission as Drawings, nor will catalog numbers of materials or equipment.

E. Each submittal shall be assigned a sequential number by the Contractor, for purposes of easy identification, and shall retain its assigned number with appropriate subscript, on required resubmissions. The assigned number shall consist of the Contract number, followed by the Specification section number where the item is specified, followed by a sequential number indicating the number of submittals in that Section (e.g., 715-01 55 28-11 is the 11th separate submittal for items specified in section 01 55 28). Resubmittals shall be identified with the same number as the original submittal, followed by the subscript R1, R2, etc. All product and material submittals shall be clearly identified with the appropriate equipment name and number as it appears in the Contract Document.

F. Shop drawing and product data lists shall be submitted to the Engineer within forty-five (45) calendar days from the Notice to Proceed in proper sequence as defined below.

G. Areas of Work where equipment, structure, materials, and integrated systems that require coordination of performance requirements, dimensions, power requirements, materials compatibility, control coordination or any submittals that may require concurrent review with others, shall be submitted as a single package.

H. The Contractor shall submit a complete list of shop drawings and product data grouped into submittal packages. The list shall be arranged by major areas and/or systems, and then subdivided by submittal packages. Each submittal package will list each Specification section and shop drawing or product data item to be submitted. After the shop drawing list has been reviewed for content by the Engineer, it will be returned to the Contractor with the Engineer's comments, if any. The Engineer's approval of the Contractor's shop drawing list is for coordination with the Engineer's requirements only. The Contractor is solely responsible for coordination of the shop drawings and product data.

I. After the approved shop drawings list has been returned to the Contractor, it shall submit the list of submittal activities to the Engineer along with specific duration and logic required to be included in the Construction schedule. Shop drawings and product data shall be coordinated by the Contractor with Drawings previously submitted by it, with Drawings being prepared by it, and with Drawings and data previously approved. Submissions shall be made to the Engineer by the Contractor only. Any data prepared by Subcontractors and suppliers and all correspondence originating with Subcontractors and suppliers shall be submitted through the Contractor. All shop drawings and product data, covering

related items of equipment or material or integrated systems of equipment or material, shall be submitted at the same time in order that their complete installation can be adequately reviewed. No partial submissions will be considered.

J. No material or equipment for which shop drawings and product data have been submitted for approval shall be delivered to the job site or incorporated into the Work until the Contractor has received copies of such approved Drawings and data, or until the Engineer has authorized it to do so, in writing. Work shall not be performed which is dependent upon the approval of another part of the Contract, until such prior written approval has been received from the Engineer.

K. The Engineer's approval of the Contractor's submittals is for general conformance only, but subject to the detailed requirements of the Contract Documents. Although the Engineer may review submittals in more or less detail, such reviewing is an effort to discover errors and omissions in the Contractor's submittals and to assist the Contractor in coordinating and expediting its Work. The Engineer's review shall in no way relieve the Contractor of its obligation and responsibility to coordinate the Work and plan the details of the Work or to relieve it of its responsibility in fulfilling the purpose and intent of the Contract. Review by the Engineer shall not be construed as placing on the Engineer, or on the City, any responsibility for the accuracy, proper fit, functioning, or performance of any phase of the Work. The Engineer reserves the right to require written confirmation from the Contractor that the comments placed on submittals stamped "Approved as Noted" will actually be followed in the prosecution of the Work.

L. All submittals must bear the stamp of approval of the Contractor as evidence that it has checked them for errors, omissions and compliance with the requirements of the Contract Documents. Submittals without this stamp of approval will not be considered and will be returned to the Contractor for resubmission. If the Drawings or other data shows variations from the requirements of the Contract Documents because of standard practice or other reasons, the Contractor shall make specific mention of such variation in its letter of transmittal. If acceptable, suitable action may be taken for prior adjustment; otherwise, the Contractor will not be relieved of the responsibility for executing the Work in full conformance with the Contract Documents even though such submittals have been approved.

M. After checking and verifying all field measurements and coordinating with other submittals, the Contractor shall submit to the Engineer for approval, two (2) sepia paper transparencies of good reproducible quality and one (1) white print of all shop drawings, which shall have been checked by and stamped with the approval of the Contractor and identified as the Engineer may require. Manufacturer's catalog cuts shall be submitted at a quantity of eight (8) of which five (5) will be retained by the City and the remaining returned with comments and/or approval to the Contractor. The Contractor shall correct the original sepia paper transparency when required, and resubmit two (2) sepia paper transparencies and one (1) white print for approval by the Engineer. One (1) paper sepia transparency will be retained by the Engineer for record purposes. The data shown on the shop drawings shall be complete with respect to dimensions, design criteria, material of construction and the like, to enable the Engineer to review the information as required. Machinery outlined Drawings alone are not acceptable. All shop drawings covering related items of equipment or integrated systems of equipment shall be submitted at the same time in order that their complete operation can be adequately reviewed. No partial submissions will be considered. At the time of each submission, the Contractor shall, in

writing, call the Engineer's attention to any deviations that the shop drawings may have developed from the requirements of the Contract Documents.

N. Within four (4) weeks after final approval of any shop drawing, the Contractor shall deliver to the Engineer one (1) "Mylar" reproducible of each approved shop drawing.

O. The Engineer will make every reasonable effort to process and return each submittal within twenty-one (21) Calendar Days after its receipt in the Engineer's office. The need for resubmission or any delay in obtaining the Engineer's review or approval of submittals shall not entitle the Contractor to an extension of time or to additional costs for interim use or Conditional Acceptance.

P. The Contractor shall furnish samples of items and materials as required in the Contract Documents. Samples, unless otherwise required by the Contract Documents, shall be submitted to the Engineer in duplicate, and each sample shall be properly labeled and identified, giving the date, the job for which it is offered, section and paragraph numbers of the Contract Documents, the Contractor, the supplier, and trade name, and shall be accompanied by Specifications, and such other pertinent data as will help in determining that the material conforms to the Contract book.

Q. A certificate submitted for a product, or component of a product shall indicate test results proving that product, or component of a product, meets the requirements of the standard specified in the Contract Documents. An affidavit consisting of a sworn statement by an official of the company manufacturing the product indicating that the information on the certificate is true and accurate shall accompany the certificate. A statement originating from the Contractor, or any of its Subcontractors, suppliers, or any other agent which merely indicates that a particular product or component of a product meets the requirements of the standard specified in the Contract Documents, shall not be considered an acceptable certificate. Any such submittal made in this manner will not be approved and the corresponding product, or component of the product, shall not be incorporated into the Work. At a minimum, all electrical and mechanical equipment shall include a certificate of installation.

R. Mix designs shall be submitted for concrete, grout, and bituminous paving. Mix design shall indicate all materials used in the product and their respective relative quantities. In any one mix design all quantities shall be expressed either by weight or volume insofar as it is practical to do so. The Contractor's attention is directed to the Standard Specifications for proportioning and testing requirements.

S. Design calculations shall be presented in a neat, legible manner and shall bear the stamp and signature of a professional engineer, registered in the State of Maryland.

T. Mill test reports shall be submitted for structural steel and concrete reinforcement steel. Reports shall be on the mill's standard report form.

U. WORKING DRAWINGS

1. The Contractor shall determine field dimensions and shall prepare whatever further detailed Working Drawings, shop drawings, cuts and brochures that are required to carry out its Work or as required by the Contract Documents. Before any Work is commenced, the Contractor shall submit to the Engineer for written approval six

(6) copies of the required Drawings, but the approval of the Engineer shall not serve in any way to release the Contractor from full responsibility for errors or omissions in any Drawings, or for the accurate and complete execution of the Work. After final approval of any Drawing or schedule, no change shall be permitted thereon unless allowed explicitly in writing by the Engineer. Any material ordered or Work performed by the Contractor prior to the approval of the Drawings shall be entirely at its own risk.

2. The words 'approved as noted' or words of similar import placed by the Engineer on a Working or shop drawing submittal means that all items and details of the Drawing submitted are fully approved with the exception of those items or details that are specifically marked for further action. The withholding of an unqualified approval by the Engineer with respect to any Working Drawing in its entirety shall, under no circumstances, constitute a basis for delay in arranging for and proceeding with the manufacturing, fabricating, delivering and installing of those items or details on such Drawings which have been approved.
3. Except as otherwise permitted by the Engineer, all shop drawings and Working Drawings, shall be completely legible on sheets, twenty-four inches by thirty-six inches (24″ X 36″) outside dimensions, and having border lines set back three-quarter inch (3/4″) on top, bottom and right hand side of sheet, and one and one quarter inches (1-1/4″) on left hand side of sheet. After all Work is completed, the Drawings shall be corrected to show all parts of the structure as finally built. The tracings shall then be turned over to the Engineer and become the property of the City. Tracings of reinforcing steel details shall be on the same size sheets specified above, but need not be turned over to the City.
4. Should the Engineer reject the shop drawings, cuts or brochures sent to him, he shall return same to the Contractor for correction and re-submittal. This shall be done as often as necessary until the Engineer shall accept such shop drawings, cuts and brochures, marking same.
5. After such shop drawings, cuts and brochures have been "Approved" by the Engineer, the Contractor shall retain two (2) copies and forward two (2) copies to the Engineer.
6. The Contractor shall keep on the job at all times copies of all approved shop drawings.
7. The approval of shop drawings by the Engineer shall not relieve the Contractor from its responsibility to coordinate the Work of the Subcontractor.
8. The approval of shop drawings does not relieve the Contractor of its responsibility to construct the Work in strict accordance with the Contract Drawings and Specifications.
9. The approval of shop drawings shall not be construed as an approval of the quantities of materials.
10. The Engineer has the right to mark on the shop drawings any changes or other notations necessary to coordinate the Work of the project. No extra payment, allowance or damages will be made or paid on account of any such changes or notations.
11. In preparing a schedule for delivery of materials and/or equipment the Contractor shall allow reasonable time for the approval of shop drawings, but in no event shall allow less than twenty-one (21) days for any such review and approval.
12. When shop drawings, cuts or brochures are forwarded to the Engineer by the Contractor for approval, a copy of the transmittal covering each transaction is to be mailed to the Engineer. Architects, structural, electrical and mechanical Engineers and all other consultants, are to follow this same procedure when it is necessary

for them to return or transfer shop drawings, cuts or brochures either between themselves or to the Contractor for changes, corrections or re-submittal, so that the office of the Engineer can record and follow the procedure of each transaction to finality.

13. All Drawings and computations shall bear the seal and signature of a professional Engineer registered in the State of Maryland. Any of the Drawings and schedules noted in (A) above, not bearing a seal, shall be returned to the Contractor without further consideration.

01 35 00 SPECIAL PROCEDURES

01 35 24 ACCIDENTS

A. The Contractor shall take any and all precautions necessary for the prevention of accidents and shall comply fully with all federal, state and municipal safety laws and regulations.

B. The Contractor shall report, in writing, to the Engineer all accidents whatsoever arising out of, or in connection with, the performance of the Work, whether on, or adjacent to, the site, which cause death, personal injury, or property damages, giving full details and statements of witnesses. In addition, if death, serious injuries or serious damage are caused, the accident shall be reported immediately by telephone or messenger, or both, to the Engineer.

C. The Contractor shall be wholly responsible for any accidents (including death) occurring at any time during the progress of the Work and until the final acceptance of the project by the City, which may happen to any of its workers or to any employee of the City, or Subcontractor employed on the Work; or for any damage or injuries (including death) which its work and operations may cause to the Work being done, or the existing buildings or to any tenants and occupants of the property, or of the adjoining properties, or to the public, or to any public or private property.

D. If any claim is made by anyone against the Contractor on account of any accident, the Contractor shall promptly report the facts, in writing, to the Engineer giving full details.

E. The Contractor shall submit a project safety plan to the City for approval. The submittal shall include the name of the individual who will be designated as the Contractor's project safety officer.

01 35 43 ENVIRONMENTAL PROTECTION PROCEDURES

A. GENERAL

This section consists of provisions required for the prevention of environmental pollution during and/or as the result of construction operations.

B. AIR POLLUTION – OPEN BURNING

Open burning within the City of Baltimore is prohibited except as permitted by Baltimore City Health Code.

C. PLANT PEST REGULATIONS

The indiscriminate movement of nursery stock, mulch, equipment and soil into and out of Maryland constitutes a potential hazard to state and national agriculture. Therefore, it shall be the responsibility of the prime Contractor to comply with all applicable state and federal plant pest regulations.

D. EROSION AND SEDIMENT CONTROL

1. Baltimore City ordinances provide that any earth moving operations within the City of Baltimore must conform to the applicable erosion and sediment control measures set forth in the Baltimore City Erosion and Sediment Control Manual and approved by the State of Maryland, Department of Natural Resources.
2. Prior to an issuance of a notice to proceed, the Contractor shall meet with the Engineer to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program. The Contractor may be required to submit, in writing, its proposal for implementing environmental pollution controls as outlined in this section.
3. The Contractor shall at all times, perform all Work in such a manner that objectionable conditions from oils, fuels, greases, bituminous materials, waste washings, herbicides, insecticides, cement, surface drainage chemical and/or solutions of chemicals and water will not be created either intentionally or accidentally in rivers, streams, lakes, ponds or storm drainage systems in, through or off-site to the project area.
4. Chemical solutions may be discharged only after first separating the chemicals from the water. The chemicals from such separation shall become the property of the Contractor and its disposition shall be subject to the regulations of the applicable federal, state and local agencies.
5. Surface drainage whether or not from completed cuts and fills within the construction limits, and from borrow and waste disposal areas, shall be held in suitable sedimentation ponds or shall be graded to control erosion within acceptable limits.
6. It shall be the Contractor's responsibility to adhere to the "Standards and Specifications for Soil Erosion and Sediment Control" in developing areas as approved and adopted by the State of Maryland, Department of Natural Resources, and furthermore, the Contractor shall adhere to the provisions of the Baltimore City Erosion and Sediment Control Manual. In addition, requirements may appear in the Special Provisions and/or the Contract plans.
7. The Contractor shall file with the Engineer, an approved grading permit containing applicable sediment and erosion control provisions. The Baltimore City Sedimentation Control representative shall be notified at least three (3) working days before the start of any Work.
8. The cost of all Work involved in connection with the construction and maintenance of erosion and sediment control required on this project shall be included in the unit prices bid for the other items, unless a specific item or items is included in the Bid proposal.
9. Temporary erosion and sediment control measures such as berms, dikes, drains, or sedimentation basins, if required to meet the above standards, shall be provided and maintained until permanent drainage and erosion control facilities are completed and operative.

10. The area of bare soil exposed at any one (1) time by construction operations shall be held to a minimum. Fills and waste areas shall be constructed by selective placement of material to eliminate surface erosion and contamination.
11. Dewatering methods proposed by the Contractor shall make adequate provision to insure against surface subsidence or settlement of structures within or reasonable proximate to both the immediate Work area and the area of influence of the dewatering systems. These methods are subject to the approval of the Engineer and various federal, state or local agencies as they apply.

E. DUST CONTROL

The Contractor shall maintain all excavations, embankments, stockpiles, access roads, plant sites, waste areas, borrow areas and all other Work areas within or without the project boundaries free from dust which would cause the standards for air pollution to be exceeded, thus causing a hazard of nuisance to others. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor shall have sufficient competent equipment on the job to accomplish this, if sprinkling is used. Dust control shall be performed as the Work proceeds and whenever a dust nuisance of hazard occurs. No separate or direct payment will be made for dust control and the cost thereof shall be considered incidental to be included in the lump sum and unit price bid for the Contract.

F. BORROW AND DISPOSAL OF CLEARED OR UNSUITABLE EXCAVATED MATERIAL

The Contractor shall notify the City sediment control representative indicating the source of all borrow material, and the disposal site for excess material. The off-site locations for disposal shall be approved by the Engineer and federal/state or local agencies having jurisdiction.

G. MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

During the construction period, it shall be the Contractor's obligation to conduct frequent training courses for its personnel. The curriculum should include methods of detection of pollution, familiarity with pollution standards, and installation and care of vegetation covers, plants and other facilities to prevent and correct environmental pollution.

H. NON-COMPLIANCE

The Engineer will notify the Contractor, in writing, of any non-compliance with the foregoing provisions and the action to be taken. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or its authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it was later determined that the Contractor was in compliance.

01 41 00 REGULATORY REQUIREMENTS

01 41 15 PATENTS, COPYRIGHTS OR TRADEMARKS

A. Whenever any machine, apparatus, article, material, means, appliance, process composition, combination or thing called for by these Specifications is covered by letters of patent, copyrights, software or trademarks, the successful bidder must secure before manufacturing, furnishing, delivering, using or employing such machine, apparatus, article, material, means, appliance, process, composition, combination, or thing, the assent in writing, of the owner or the licensee of such letters of patent, copyrights, software or trademarks. This written permission shall be filed with the Engineer; the said assent shall cover not only the use, employment and incorporation of such machine, apparatus, article, material, means, appliance, process, composition, combination or thing in the said buildings and other Work to be done, and/or constructed, but also the permanent use thereafter of such machine, apparatus, article, material, means, appliance, process, composition, combination or thing in connection with the use of said buildings and Work for the purpose for which they or any of them are intended or adapted. The Contractor shall absorb, in its Bid, the patent fees or royalties on any patented article or process furnished or used in the Work.

B. The Contractor shall be responsible for any and all claims and demands of any kind, character or description made against the City, its agent or employees, for any actual or alleged infringements of patents, copyrights, or trademarks in or by the manufacturing, construction, furnishing, delivery and/or installation of any such machines, apparatus, articles, materials, means, appliances, processes, compositions, combinations or things in the performance and completion of the Work, and/or in the subsequent use of said buildings and/or Work, for their intended purposes. To the fullest extent permitted by law the Contractor shall defend, save harmless and indemnify the City, its agents and its employees from any and all costs, expenses and damages of every nature, including solicitors and attorney's fees, expert fees and consulting fees, which the City, its agents, employees, consultants and representatives may be obliged to pay by reason of any such actual or alleged infringements of patents, copyrights or trademarks.

01 41 18 LIMITATION OF LIABILITY

It is understood and agreed that any and all of the duties, liabilities and/or obligations imposed upon or assumed by the Contractor and the Surety, or either of them, by or under the Contract Documents and Bonds, shall be taken and construed to be cumulative. Additionally, that the mention of any specific duty, liability or obligation imposed upon or assumed by the Contractor and/or Surety under the Contract Documents and Bonds shall not be taken or construed as a limitation or restriction upon any or all of the other duties, liabilities and/or obligations imposed upon or assumed by the Contractor and/or the Surety by or under the Contract Documents and Bonds.

01 41 20 EMPLOYEES AND EQUIPMENT

Any employee of, or person connected with, the Contractor who shall use profane or abusive language to the Engineer, Inspector, or other employee or representative of the City, or otherwise interfere with the performance of their duties, or who shall disobey or

evade its instructions, or who is careless or incompetent, or who is objectionable to the City authorities, shall be discharged at the request of the Engineer, and shall not again be employed in connection with the Work except with the Engineer's consent. The Contractor shall furnish such equipment as is considered necessary for the prosecution of the Work in an acceptable manner and at a satisfactory rate of progress, approved by the Engineer. Failure of the Engineer to identify any such equipment shall not release the Contractor from its obligations to prosecute the Work as required. Equipment used on any portion of the Work shall be such that no injury to adjacent Work or property will result from its use.

01 41 21 REMEDIES CUMULATIVE

All remedies provided in the Contract Documents shall be taken and construed to be cumulative; that is, in addition to any and all other remedies provided therein and to any remedies in law or equity which the City or Contractor would have in any case.

01 41 26 PERMITS, LICENSES, CHARGES, AND NOTICES

A. The Contractor shall, prior to or at the time of executing the Contract and bond herein referred to, exhibit to the Engineer all licenses required for the performance of Work referred to herein, including but not limited to the license required under the Code of Maryland.

B. GENERAL

1. In addition to the requirements of the City Standard Specifications, the Contractor shall comply with those requirements of the Baltimore City building code which are more stringent, but only to the extent of such requirements.
2. The Contractor shall give all necessary notices, obtain all permits (except as otherwise noted herein) and pay all governmental taxes, fees, and other costs in connection with the Work, file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction, obtain all required certificates of inspection and approval for the Work and deliver same to the Engineer, except as otherwise noted herein.
3. All Work, equipment and material shall comply with the National Electric Code, National Plumbing Code and all local codes.
4. All motors, pumps and electrically driven units shall bear an Underwriters' Laboratories (UL) label. If it is not possible for the item to be furnished with a UL label, the Contractor shall have a certified testing agency certify that the equipment is acceptable to UL Standards.

C. INCLUDED ITEMS

The Contractor shall include in the Work without extra cost to the City, all labor, materials, services, apparatus, and Drawings required to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on the Drawings, and/or specified.

D. COMPLIANCE

1. All materials furnished and all Work installed shall comply with the rules and regulations of the National Fire Protection Association, with all requirements of

local utility companies, with the recommendations of the fire insurance rating organization having jurisdiction, and with the requirements of all governmental departments having jurisdiction, and specifically the Baltimore City Code, latest edition and all amendments thereto.

2. The Contractor shall arrange for inspection and approval by the Building and Electrical Inspectors of Baltimore City and shall pay all costs required for these services.

E. The Contractor shall give all notices necessary and incidental to the due and lawful prosecution of the Work and, upon request of the Engineer, submit written evidence of compliance with these provisions.

01 45 00 QUALITY CONTROL

01 45 01 INSPECTION OF MATERIALS AND WORK

The Contractor shall furnish all labor to facilitate the securing of test samples by the Engineer. The Contractor shall also furnish the Engineer with every reasonable facility for ascertaining whether or not the Work as performed is in accordance with the requirements and intent of the Specifications and Contract. If the Engineer requests it, the Contractor, at any time before acceptance of the Work, shall remove and/or uncover such portions of the finished Work as may be directed. After examination, the Contractor shall restore said portions of the Work to the standard required by the Specifications. Should the Work thus exposed or examined prove acceptable, the uncovering, removing, replacing of the covering and/or making good of the parts removed, shall be paid for as "Extra Work"; but should the Work exposed or examined prove unacceptable either in whole, or in part, the uncovering, removing, replacing of the covering and/or making good of the parts removed, shall be at the Contractor's sole expense. Any Work done or materials used without suitable supervision or inspection by a representative of the Engineer may be ordered removed and replaced at the Contractor's sole costs and expense regardless of the quality of the Work.

01 45 14 QUALITY OF MATERIAL

A. All materials furnished and all Work done in carrying out the Contract shall be of the best quality and especially adapted to the services required. Wherever the characteristics of any material are not particularly specified, such material shall be used as is customary in first-class work of the nature for which the material is employed.

B. The source of supply and quality of each of the materials shall be approved by the Engineer before delivery is started. The Engineer shall be notified of the time and place of preparation, manufacture or construction of all material, equipment and devices, for all or part of the Work, before delivery at the site of the Work. This notification shall be given at least two (2) business days in advance of the beginning of the Work on such material, equipment and devices to allow arrangements to be made for inspecting and testing. The Engineer or its authorized representative, for examination or test, shall take representative preliminary samples of the character and quality herein described. Written approval of the quality of such samples shall be received by the Contractor prior to obtaining materials from the respective sources of supply. Only such materials as conform to the requirements of these Specifications shall be used in the Work. All

materials submitted for use may be inspected at any time during the progress of their preparation and use. All materials shall be approved before being incorporated in the Work.

C. Representative samples of all materials requiring laboratory test shall be taken by the Engineer or its authorized representative, and such materials shall be used only after written approval has been received by the representatives of the Engineer in charge of the Work, and only so long as the quality of said materials remains equal to the requirements.

D. The Contractor is referred to the requirements of Division 01 33 10 concerning submission and approval of a materials list prior to purchase of materials and equipment for use on this project.

E. Shop drawings for materials and items of equipment, which are not on the approved materials list, will not be reviewed, and will be returned to the Contractor unchecked.

01 45 14.01 EQUIPMENT AND DEVICES

All equipment, apparatus, and/or devices of any kind, shown or indicated on the Drawings, or called for in the Specifications, or required for the completion of the Work, shall be entirely satisfactory to the Engineer with regard to operation, capacity, and/or performance. No approval, either written or verbal of any Drawings, descriptive data or samples of such equipment, apparatus and/or devices shall relieve the Contractor of its responsibility to turn over the same in perfect working order at the completion of the Work. Any equipment, apparatus and/or device not fulfilling these requirements shall be removed and replaced by proper and acceptable equipment or put in good working order, to the satisfaction of the Engineer, without additional cost to the City.

01 45 15 ACCESS TO WORK

The Engineer or his duly authorized representatives may, at any time, enter upon the Work and the premises used by the Contractor, and the Contractor shall provide proper and safe facilities by means of ladders or otherwise, to secure convenient access to all parts of the Work, and all other facilities necessary for inspection, as may be required by the Engineer.

01 45 16.01 DEFECTIVE MATERIALS AND WORK

All materials not conforming to the requirements of these Specifications shall be considered as defective, and all such materials, whether in place or not, shall be rejected and shall be removed immediately from the Work unless otherwise permitted. No material that has been rejected, the defects of which have been corrected or removed, shall be used until written approval has been given. All Work which has been rejected or condemned shall be remedied, or if necessary, removed and replaced in an acceptable manner by the Contractor at its own expense.

01 45 16.13 FAILURE TO REMOVE AND RENEW DEFECTIVE MATERIALS AND WORK

Should the Contractor fail or refuse to remove and renew any defective materials used or Work performed previously or to make any necessary repairs in an acceptable manner, and in accordance with the requirements of these Specifications, within the time indicated in writing, the Engineer shall have the authority to cause the unacceptable or defective materials or Work to be removed and renewed or such repairs to be made at the Contractor's own expense. Any expense incurred by the City in making these removals, renewals, or repairs, which the Contractor has failed or refused to make, shall be paid out of any monies due or which may become due to the Contractor, or may be charged against the "Contract Bond" deposited; and continued failure or refusal on the part of the Contractor to make any or all necessary repairs, removals and renewals promptly, fully and in an acceptable manner, shall be sufficient cause for the City to declare the Contract forfeited in which case the City, at its option, may purchase tools, materials and equipment and employ labor, as may be required to perform the Work, or may Contract with any other individual, firm or corporation to perform the Work. All costs and expenses incurred thereby shall be charged against the defaulting Contractor and the amount thereof deducted from any monies due or which may become due it and/or shall be charged against the "Contract Bond" deposited. The performance of any Work by the City and/or others as specified shall not relieve the Contractor in any way from its responsibilities. All the provisions of this paragraph shall be applicable during the entire period from the beginning of the Work, to and including, its final completion and acceptance.

01 45 17 AUTHORITY AND DUTIES OF ENGINEERS AND INSPECTORS

A. Engineers and Inspectors, employed by the City and any other agency of jurisdiction, shall be authorized to inspect all Work done and materials furnished. Such inspection may extend to all or any part of the Work and to the preparation or manufacture of the materials to be used. An Inspector shall be assigned to the Work to report to the Engineer as to the progress of the Work and the manner in which it is being performed; also to report whenever it appears that the materials furnished and Work performed by the Contractor fail to fulfill the requirements of the Specifications and Contract, and to call to the attention of the Contractor any such failure or other default; but no inspection, nor any failure to inspect, at any time or place, shall relieve the Contractor from any obligation to perform all of the Work strictly in accordance with the requirements of the Specifications and other Contract Documents. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the Work, the Inspector shall have the authority to reject materials or suspend the Work until the question at issue can be referred to and decided by the Engineer. The Inspector shall perform such other duties as are assigned to them. The Inspector shall not be authorized to revoke, alter, enlarge, relax or release any requirements of these Specifications, nor to approve or accept any portion of Work, or to issue instructions contrary to the Plans and Specifications. The Inspector shall in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the Work by the latter. Any instructions which the Inspector may give the Contractor shall in no way be construed as in any way releasing the Contractor from fulfillment of the terms.

B. Any and all inspections required by or referred to in the Contract Documents may be performed either by City employees or by one or more private inspection agencies

contracting with the City to furnish inspection service. All inspection Work performed by private inspection agencies shall be subject to the approval of the Engineer.

01 45 24.01 FIELD LABORATORY

A. At proportioning, batching or mixing plants operated by the Contractor, a building suitable for a field laboratory will be provided in which to house and use the equipment necessary to carry on the various tests required. This building shall be for the exclusive use of the Engineers and Inspectors for testing and recording purposes. Its size shall be not less than eight feet (8') wide by twelve feet (12') long with a seven foot (7') minimum ceiling height. It shall be maintained watertight. It shall have at least three (3) windows and a private entrance door equipped with a lock. Windows and doors shall be adequately screened. Satisfactory lighting and heating shall be supplied; electric lights, duplex convenience outlets and current shall be provided. A table or desk having top dimensions not less than thirty inches (30") by sixty inches (60") shall be provided, together with a workbench measuring at least thirty-six inches by seventy-two inches (36" X 72") and forty inches (40") high with adequate drawer or cupboard space. At least two (2) chairs shall be provided. The building shall be so located that the plant shall be in full view from a window near the workbench. Telephone facilities shall be provided by the Contractor in the field laboratory, in addition to like facilities provided elsewhere on the project, for the exclusive use of test personnel so that communications can be promptly transmitted to and from the municipal building in Baltimore and the field laboratory. Payment for telephone service will be deemed to be included in the price as specified in paragraph D below.

B. Approval of a plant for the proportioning, batching or mixing of portland cement concrete, bituminous concrete or their components will be contingent upon the availability of a field laboratory such as described above for the exclusive use of the Engineer or Inspector.

C. When required by Special Provisions there shall be provided in addition to the above, a portable housing having a minimum floor space of sixty square feet (60') with a window to furnish a minimum of ten square feet (10') of natural light. This housing shall be for the exclusive use of the Engineer, or Inspectors, for conducting field density tests for embankment compaction, making reports, and storing necessary equipment and supplies, and the Contractor shall make all reasonable moves of same as directed. It shall be entirely closed, waterproofed and provided with an entrance and satisfactory lock. It shall be equipped with at least one (1) table thirty-six inches by forty-eight inches (36" X 48") by forty inches (40") high, and one (1) closet equipped with lock for storing equipment. Satisfactory heating and air conditioning capable of providing comfortable working conditions during cold or hot weather conditions shall be supplied.

D. A lump sum bid shall be provided for provision of facilities as described above.

01 45 24.02 RESPONSIBILITY OF CONTRACTOR FOR PLANT AND METHODS

The Contractor shall provide and install such construction plants and/or coordinated equipment, tools and machinery, and shall use such methods and appliances for the performance of all operations connected with the Work to be done under the Contract as will secure the most satisfactory quality of Work and a rate of progress, which, in the opinion of the Engineer, will insure the completion of the Work within the time specified. If at any time before commencement or during the progress of the Work or any part of it,

such methods and appliances appear to the Engineer to be unsafe, inefficient or inadequate for securing the safety of the workers, the prescribed quality of the Work or the rate of progress required, the Engineer and/or the Engineer's designated representatives may order and/or direct the Contractor to increase its safety and efficiency, or to improve its character without additional costs to the City. The Contractor shall immediately comply with such orders and/or direction, but the failure of the Engineer to make such demand or give such order or direction shall not release the Contractor from its obligations to secure the maximum safety in all operations, the best quality of Work, and the rate, progress and/or efficiency required by the Contract Documents. The Contractor alone shall be responsible for the safety, efficiency and adequacy of its plant, labor, equipment, materials, appliances, means and methods and the resulting quality of the Work.

01 45 25 TEST OF MATERIALS

All material before being incorporated in the Work shall be inspected, tested and approved by the Engineer, and any Work in which such materials are used without prior test and approval or written permission of the Engineer shall be considered defective and unauthorized and will not be paid for. Tests will be made at the expense of the City, unless otherwise noted in these Specifications. Unless otherwise designated, when a reference is made in these Specifications, to a specification, or test designation of AASHTO, ASTM, federal Specifications, or any other recognized nonproprietary national organization, it shall mean the specification or test method (including interim AASHTO and tentative ASTM) which is current on the date of advertisement for bids. Samples will be taken by a representative of the City. All materials being used are subject to inspection, test or rejection at any time during the preparations and use.

01 45 30 TESTING STANDARDS

Wherever in the Contract Documents references are made to specific test methods, serial designations, standards and/or requirements, it shall be understood that the latest methods, designations, standards and/or requirements are intended and shall apply, except to the extent that said methods, designations, standards and/or requirements may be in conflict with applicable laws, ordinances, etc.

01 45 34 USE OF EXPLOSIVES

In using explosives the Contractor shall observe the utmost care so as not to endanger life or property. The explosives shall be stored in a secure and safe manner. All such storage places shall be marked clearly "DANGEROUS – EXPLOSIVES" and shall be in the care of competent watchmen at all times. It is essential that the Contractor familiarizes itself with and strictly conforms to all federal, state, county and municipal laws, ordinances, rules and regulations pertaining to the handling, transportation, storage and use of explosives. The Engineer will furnish information as to rules and regulations regarding the use of explosives. All blasting shall be done in the presence of a blasting Inspector. The Contractor will not be charged for such inspection. Also see 31 23 33, 3.6 (Blasting).

01 51 00 TEMPORARY UTILITIES

01 51 13 TEMPORARY ELECTRICAL SERVICES

The City does not guarantee electric service.

01 51 23 TEMPORARY HEAT

A. The Contractor shall furnish at its own expense, such temporary heat, including apparatus, fuel as may be necessary to fully protect the Work, both during its execution and until final completion and acceptance of the Work. If the Engineer so orders, the Contractor shall continue to provide heat for the Contract from the time of Final Acceptance and completion of the Contract until it is taken over and heating plant is operated by the City of Baltimore, and the Contractor shall be paid for all cost of heating during the Contract after the Final Acceptance. Method of heating shall be approved by the Engineer.

B. In order to permit the Work to continue during all seasons of the year, the Contractor, at its own expense, shall protect its Work at all times from the harmful effects of low temperatures. The Contractor shall be responsible for providing all necessary heat so that the various classes of Work performed by it are kept at the temperatures required.

C. The heating system used by the Contractor shall be as approved by the Engineer and shall not deface, discolor, or cause the deposition of dirt or smudge upon any finished Work, nor shall it be injurious or harmful to the workers.

01 51 33 TEMPORARY TELECOMMUNICATIONS

The Contractor, at its own expense, shall arrange for temporary telephone service required by it in the performance of its Work.

01 51 36 TEMPORARY WATER

A. Where water from City water mains is available, the Contractor shall not be required to pay for water used. However, the means by which the water is supplied from the water main (through fire hydrant, regular water service installation, or restoration of an abandoned water service) is the responsibility of the Contractor. All charges for the installation and abandonment of water services, or the fees and charges for fire hydrant permits shall be at the Contractor's own cost and expense.

B. The Contractor shall procure from the City a permit for the use of any fire hydrant and obtain a regular wrench for use on hydrants and no other wrench shall be used. It shall conform to all the rules and regulations of the City in connection with the use of water, hydrants, pipes, etc.

C. Where City water is not available, the Contractor shall, at its own cost and expense, provide such quantities of clear water as may be required for any and all purposes under the Contract. It shall supply sufficient drinking water to all its employees, but only from

such sources as are approved by the Engineer and no other water shall be used for drinking purposes.

01 51 37 TEMPORARY SANITARY FACILITIES

The use of existing toilet facilities at the City's site by the Contractor's personnel is strictly forbidden. The Contractor shall provide, at its own expense, temporary sanitary facilities for its employees. Sanitary facilities shall conform to 01 52 19, of these general conditions.

01 52 00 CONSTRUCTION FACILITIES

01 52 19 SANITARY PROVISIONS

The Contractor shall provide and maintain in a neat and sanitary condition such sanitary conveniences and accommodations for the use of its employees as may be necessary to comply with the requirements and regulations of the Department of Health or of other bodies or tribunals having jurisdiction thereof.

01 55 00 VEHICULAR ACCESS AND PARKING

01 55 26 MAINTENANCE OF TRAFFIC

A. The Contractor shall provide, erect, maintain and remove such traffic controls, temporary barricades, signs, warning lights and other means for the protection of the public, safeguarding of vehicular traffic and maintenance and protection of all railway traffic, in the immediate vicinity of the project site at all times during the life of the Contract.

B. No highway, roadway, alley, lane, etc., that is used by the public shall be closed to traffic at any time, unless a permit is issued to do so by the Engineer. The Engineer also reserves the right to restrict the Work on highways, roadways, alleys, lanes, etc., to certain hours of the day or night and to limit the extent of the Work where traffic conditions, in their opinion, so warrant. On highways that are to be constructed or reconstructed in their entirety, the Contractor shall so conduct its Work so that proper maintenance and control of traffic both within and adjacent to the project site is a prime requisite. Stipulations, which must be strictly observed, regarding the maintaining and controlling of traffic, during the life of the Contract, may be found in Special Provisions.

C. The Contractor shall provide access for the safe passage of pedestrians and vehicles on, through and within the construction site to all existing entrances and driveways for local residents and business establishments affected by the construction Work. Access to and including the driveway entrances shall be maintained in a safe and passable condition as determined by the Engineer. The Contractor shall so plan and regulate its Work that access for local traffic is available to the properties at all times.

1. In the event the Contractor chooses to provide access for local residences and business establishments through private property, it shall be its sole responsibility to acquire the easement and perform all Work to provide the access. The cost to provide the access through private property shall be at the expense of the Contractor.

D. On highways that are to be surfaced, resurfaced and/or surface treated, the Contractor shall carry on its Work in such a manner that the highways and roadways will be open to traffic at all times. On intersecting streets not more than one-half (1/2) of the width of either highway shall be closed to traffic at any time.

E. Street railway traffic shall be maintained at all times, unless otherwise provided.

F. The protection and maintenance of railroad traffic, when required at the project site, shall be outlined in detail in the Special Provisions. The rules, regulations, and requirements as set forth therein must be strictly observed whenever the tracks, structures or property of any railroad is involved or affected by construction and/or demolition.

G. Barricades shall be constructed of timber, shall conform in all respects to any details as may be shown on the Plans, and shall be not less than six feet (6′) in height. They shall be completely sheathed on the outside and the posts shall be securely anchored to existing structures, or embedded in the ground, as the case may be. Suitable doors shall be provided where necessary for authorized access to the construction area. The barricades will be substantially constructed and shall be approved by the Engineer. The outside surfaces of all barricades facing vehicular traffic shall be marked with alternate black and white, or orange and white diagonal bands, in accordance with the Manual of Uniform Traffic Control Devices.

H. All barricades shall be adequately illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise. The Contractor shall provide and maintain warning signs for the barricades specified herein. The signs shall be at least two feet (2′) high by three feet (3′) long, with letters at least six inches (6″) in height; these letters to be black on white background or black on orange background in accordance with the Manual of Uniform Traffic Control Devices.

I. The Contractor shall also provide a sufficient number of security personnel and take all necessary precautions for the protection of the Work and safety of the public.

J. After the barricades have served their purpose, they shall become the property of the Contractor, and shall be removed from the project site and disposed of by the Contractor at its own cost and expense. Any paved areas damaged as a result of anchoring of the barricades shall be repaired at the Contractor's expense and to the satisfaction of the Engineer.

K. In addition to the above mentioned barricades, the Contractor will be required to provide acceptable wire fences at other locations on the site if so directed by the Engineer.

L. The cost of maintaining traffic as noted above shall be considered as incidental to other items and included in the price Bid for them except when a special item for “Maintenance of Traffic” is provided in the proposal.

M. The Contractor shall at all times, delineate the Work site for pedestrian and vehicular traffic, including pre-warning guide signs, flashing lights and barricades in accordance with state and local guidelines.

N. During any base repair operations, adjustment to utility structures or any other repair operations, the Contractor shall block only one (1) continuous lane of traffic at a time.

O. During any curb and gutter repair, the Contractor shall place Type II Barricades with flashers in such a way as to straddle the Work site and not obstruct the free flow of traffic. Also, the Contractor shall not place any excavated curb, curb and gutter, and curb forms in such a way as to obstruct the free flow of traffic.

P. The Contractor shall notify the Department of Transportation, at least two (2) weeks prior to beginning Work.

Q. The Contractor shall maintain ALL existing traffic signal equipment (surface and sub-surface).

1. Should the scope of Work necessitate relocation or adjustment of any traffic signal equipment, the Contractor must notify the Engineer at least one (1) week prior to the required change, since such changes will be performed by Department of Transportation personnel, unless otherwise directed.

R. The Contractor shall maintain ALL existing traffic signs, parking meters and all supporting structures (channel iron posts, street name posts, parking meter posts, street lights or signal poles).

1. The Contractor is required to make a complete inventory of the exact location and descriptions of the above equipment. Copies are to be submitted to the Department of Transportation for approval, prior to beginning any Work.
2. Should the scope of Work necessitate the temporary removal of any traffic signs or parking meters or their supporting structures, the Contractor must adhere to the following procedures:

    a. Contractor must first assume liability for the control of the affected traffic by whatever means necessary (flagman or temporary signing).
    b. Contact the Engineer and Department of Transportation, at least twenty-four (24) hours in advance, to arrange for that office to handle removal of any parking meters, since the Contractor is Prohibited from tampering with these devices.
    c. Remove affected signing and/or supporting structures.
    d. Complete the Work in that area. Reinstall affected signing and support structures to original locations.
    e. Return control of traffic to normal.

3. Should the scope of Work require the permanent relocation or change of any traffic signs or parking meters and their supporting structures (street alignment change or widening), the Contractor must notify the Engineer and Department of Transportation, at least one (1) week prior to the required change, since such changes will be performed by Department of Transportation personnel, unless otherwise directed.

S. The Contractor shall not work within one hundred feet (100′) of any signalized intersection between the hours of 7:00 A.M. to 9:00 A.M. and 4:00 P.M. to 6:00 P.M.

T. The Contractor shall, at all times, maintain a minimum six foot (6′) pedestrian footway on all sidewalks under construction, unless a building line or vault prohibits the Contractor from maintaining this width. Where this is the case, the Contractor shall maintain one-half (1/2) the distance from the curb to the building/vault line for pedestrians, provided this leaves a minimum of four feet (4′) of unobstructed footway.

1. Any change to the above-mentioned conditions on footways, will require the Contractor to submit a plan for maintenance of pedestrian traffic to the Engineer, and the Department of Transportation.

01 55 26.01 PUBLIC CONVENIENCE AND SAFETY

The Contractor at all times shall conduct the Work in such a manner as to insure the least obstruction to traffic practicable. The convenience of the general public and of the residents and occupants of property along and adjacent to the Work shall be provided for in an adequate and satisfactory manner. Materials stored upon any highway shall be placed so as to cause as little obstruction to the traveling public as is considered necessary. Fire hydrants on or adjacent to the Work shall be kept accessible to fire apparatus at all times and no material or obstruction shall be placed within ten (10) feet of any such hydrant. Footways and portions of highways adjoining the Work under construction shall not be obstructed more than is absolutely necessary. All gutters and sewer inlets shall be kept unobstructed at all times. In no case shall any traveled thoroughfare be closed, without the written consent of the Engineer.

01 55 26.02 FLAGGER

A. On all projects, traffic controls for highway construction and maintenance operations shall comply with current state and federal guidelines on uniform traffic control devices and conform in every respect to the requirements of the State Highway Administration Manual of Traffic Controls for Highway Construction and Maintenance Operations.

B. It shall be the Contractor's responsibility to maintain both highway and pedestrian traffic safety adequately and continuously on all portions of existing roadways, bridges and walkways affected by its Work. Only persons who are qualified and who are fully instructed and understand their duties and responsibilities will be used as flagmen. Personnel assigned to this duty shall wear a solid color fluorescent orange and white coat or vest and be so positioned that approaching drivers can see them from a distance of at least five hundred (500) feet.

01 55 27 BARRICADES, DANGER, WARNING, AND DETOUR SIGNS

A. On all projects, traffic controls for highway construction and maintenance operations shall comply with, in every respect, the requirements of the State Highway Administration Manual of Traffic Controls for Highway Construction and Maintenance Operations.

B. Approved lighting shall be placed along the exposed sides of all trenches at night as required for necessary warning to the public. In no case shall the lights be placed farther than twenty (20) feet apart.

C. Guard railings or barricades shall be provided at or near the sides of trenches as necessary to protect the workmen and the public. The description of the type of guardrail or barricade to be used shall be submitted to and approved by the Engineer prior to starting any Work.

D. The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient lights, danger signals and signs, provide a sufficient number of security personnel, and take all necessary precautions for the protection of the Work and safety of the public. Highways closed to traffic shall be protected by effective barricades, on which shall be placed acceptable warning signs. All lights shall be electric lights and kept operating from sunset to sunrise.

01 55 28 DETOURS

A. On all projects, traffic controls for highway construction and maintenance operations shall comply with the Manual on Uniform Traffic Control Devices and conform in every respect to the requirements of the State Highway Administration Manual of Traffic Controls for Highway Construction and Maintenance Operations.

B. Detours may be indicated on the Plans or in the Special Provisions, or at the Contractor's request. Traffic may be detoured over approved routes along existing streets when acceptable to the Engineer. Detours over existing streets will be designated, marked and maintained by the City. All other detours will be the responsibility of the Contractor.

01 58 00 PROJECT IDENTIFICATION

A. Project Sign: The Contractor shall furnish, install and maintain one (1) project sign at a location as directed by the Engineer.

B.

1. The sign shall be a maximum forty-eight inches by seventy-two inches (48″ X 72″) maximum size, adequately supported as site conditions may require. Mount sign at a proper distance above grade to permit public viewing.
2. Sign shall be build of three-quarter inch (3/4″) exterior type, high density overlaid plywood, or equal. It shall be bonded along the edges of the plywood with a one inch by four inch (1″ X 4″) wood strip fastened flat to the edge of the sign at the middle of the width of the strip.
3. Immediately after the awarding of the Contract, the Contractor shall contact the Engineer for information regarding wording, coloring and size of letters.
4. The sign shall be installed prior to the start of any construction operations on this project, and will be paid for as part of the Contractor's project mobilization proceedings.
5. It shall be the responsibility of the Contractor to protect and maintain the sign in good condition throughout the life of the project.
6. The sign shall be removed when directed by the Engineer and shall then become the property of the Contractor.

7. The cost of the project sign as noted above shall be considered as incidental to the Work and included in the lump sum price bid.

01 66 00 PRODUCT STORAGE AND HANDLING REQUIREMENTS

01 66 10 STORAGE OF MATERIALS

A. Materials shall be stored so as to insure the preservation of their quality and fitness for the Work. When considered necessary, material shall be placed on wooden platforms or other hard, clean surfaces and not on the ground, and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection. Lawns, grass plots, tree protection areas, and private or public property shall not be used for storage purpose without written permission of the owner or lessee or the Tree Protection Expert.

B. Contractor Storage Area

1. A storage area may be assigned near the site, as shown on the Contract Drawings. The exact limits of the areas will be designated in the field by the Engineer. The Contractor shall be fully responsible for the security of this area, including fencing, watchmen, and other means of security of any property belonging to the Contractor, its Subcontractors, or any of its work force.
2. The Contractor shall grade and stabilize a portion of the assigned storage area for a temporary mobilization and parking area for its use during the Contract period and shall restore the entire storage area to its original condition upon completion of the project.

01 71 00 EXAMINATION AND PREPARATION

01 71 13 MOBILIZATION

A. This Work shall consist of the construction preparatory operations, including the movement of personnel and equipment to the project site and for the establishment of the Contractor's offices, buildings and other facilities necessary to begin Work.

B. All Work performed in providing the facilities and services shall be done in a safe and workmanlike manner.

C. Mobilization will not be measured but will be paid for at the Contract lump sum price. The cost of all required insurance and bonds will be incidental to the mobilization item.

D. Payment of fifty percent (50%) of the mobilization item will be made in the first monthly estimate after the Contractor has established the necessary facilities. The remaining fifty percent (50%) will be prorated and paid in equal amounts on each of the next five (5) monthly estimates. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the Work.

E. Payment of the mobilization item will not be made more than once, regardless of the fact that the Contractor may, for any reason, shut the Work down on the project, move their equipment away from the project and then back again.

F. If an item for mobilization is not provided, the cost of mobilization including the required insurance and bonds will be incidental to the other items specified in the Contract Documents.

01 71 25 TEST PITS

Test pits shall be excavated at such points and of such dimensions and depth as is necessary to verify the horizontal and vertical location of various subsurface structures, utilities or other subsurface conditions prior to the performance of Work in the applicable area, or in such other locations from time to time as the Engineer may direct. It is understood that the purpose of these test pits is to verify, so far as practical, the horizontal and vertical location of various subsurface structures, utilities and/or other various subsurface conditions prior to the performance of Work affected thereby.

01 71 33 ADJACENT BUILDINGS AND PROPERTY

It shall be the Contractor's responsibility to support and protect all buildings and property on or adjacent to the project site against settlement and damage during construction operations by adequate shoring, bracing, sheeting, etc., acceptable to the Engineer. In case of any settlement or damage to such buildings or property, the Contractor shall, at its own cost and expense, restore such buildings and property to a condition equal to that which existed before the damage was done.

01 73 00 EXECUTION

01 73 26 SALVAGEABLE MATERIALS

Granite curb, belgium blocks, granite blocks and cobblestone removed from any project, shall be salvaged by the Contractor and delivered per direction of the Engineer. Only bituminous concrete attached directly to these materials will be accepted. All other roadway and foreign materials shall be disposed of by the Contractor. The Contractor shall contact the Engineer, forty-eight (48) hours in advance of hauling material. The described materials shall become the property of the City. There will be no additional payment for this operation, the cost to be included in the various items in the Proposal.

01 74 00 CLEANING AND WASTE MANAGEMENT

01 74 13 PROGRESS CLEANING

The Contractor shall keep the premises as clean as the progress of the Work will permit, and on completion, remove all surplus materials and rubbish from the premises, leave the building clean, as acceptable to the Engineer, wash all windows, glazed doors, glazed partitions, etc., and do any further cleaning called for under other headings. All floors shall be scrubbed, and all spots removed by methods approved by the Engineer.

01 74 16 MAINTAINING FLOW OF SEWERS AND DRAINS

The Contractor shall, at its own cost and expense, provide for and maintain the flow of all sewers, drains, house or inlet connections, and all watercourses, which may be met with during the progress of the Work. The Contractor shall not allow the contents of any sewer, drain house or inlet connection to flow into the trenches, drains and/or sewers to be constructed under the Contract, except where written permission is given by the Engineer, and shall at its own cost and expense immediately remove from the proximity of the Work all offensive matter, using such precautions in so doing as may be directed by the Engineer.

01 74 16.01 BYPASS PUMPING FOR WASTEWATER FACILITIES UNDERGOING CONSTRUCTION

A. The mission of the City-owned facility that is undergoing expansion, renovation or other improvements shall not be compromised by the pursuit of Contract Work. Hydraulic capacity and throughput shall be maintained at all times by the proper operation of temporary bypass pumping facilities installed for this express purpose.

B. Facilities shall not be shut down except by direct permission of the Engineer who shall in turn have the concurrence of the facility operator.

C. Temporary bypass pumping facilities shall be constructed in accordance with the Contract Documents. They shall be inspected and demonstrated to be in good operating order and capable of fulfilling the requirements of the Contract Documents, subject to the express approval of the Engineer.

D. The Contractor shall furnish an operation plan for approval by the Engineer prior to start up of the temporary bypass pumping operation. The startup plan shall include at a minimum the procedures for operation of the pumping system, emergency notification of emergency personnel for repair of equipment, a staffing plan for the continuous on site staffing and operation of the pumps and other equipment, and a procedure for containment and clean up of any sewage spills. The operation plan shall bear the signature of a certified wastewater operator.

E. The certified operator shall hold a current certificate in the appropriate class as issued by the Maryland State Board of Certification of Water and Waste Systems Operators. Said operator shall be responsible for the proper operation of the temporary bypass pumping facilities. During the operation of the temporary bypass facilities the certified operator provided by and working for the benefit of the Contractor shall have the responsible charge of the facility and shall remain accountable for its operation whether on site or not.

F. The temporary bypass pumping facility shall remain in operation until such time as it is no longer deemed to be necessary. This decision shall be solely at the discretion of the Engineer. At a minimum, the permanent facilities constructed shall be installed and accepted by the Engineer and beneficial occupancy by the City has taken place. Then and only then shall the Contractor request permission to decommission the temporary bypass pumping facility.

01 74 20 EXCAVATED MATERIAL TO BE DISINFECTED

If so required, the material excavated shall be deodorized or disinfected by the Contractor, to the satisfaction of the Commissioner of Health, without charge therefore.

01 75 00 STARTING AND ADJUSTING

01 75 16 START-UP PROCEDURES FOR SEWAGE PLANTS

A. Purpose and Scope: The purpose of the plant operation by the Contractor is to start up and operate the facilities to demonstrate that the facilities are constructed in accordance with the Contract Documents, will operate on a continuous basis and will achieve the specified performance. The Contractor shall provide all operational planning and expertise, supervision, manpower, maintenance, tools, equipment, spare parts, oils and lubricants, facilities, incidental materials, periodic reports, services of manufacturer's representatives, and all else to operate the completed facilities for the prescribed period in accordance with the conditions stipulated.

B. Readiness to Operate: When the Contractor has substantially completed the Work, it shall notify the Engineer in writing, requesting permission to start up and requesting permanent diversion of the sludge flow by the City to the new facilities. Prior to this request, the Contractor shall satisfy the Engineer, during a joint inspection requested in writing, that all facilities are complete and ready to operate. All equipment and systems shall have been completed and tested prior to such inspection and all manufacturers' certificates and operating and maintenance manuals shall have been delivered to the Engineer and accepted as satisfactory. The Engineer will respond in writing, authorizing the start up of the facilities or will state specific reasons why the operation may not commence.

C. Plan of Operation: The Contractor shall include, with its request, a plan showing how it will start up the facility without disrupting existing operations. Such permission will be granted by the City as long as no disruption to its treatment processes or expense is suffered by the City. In the case of water and wastewater facilities, full flow is defined as all design flow into the new facilities. The Contractor's request shall state the names and qualification of all the licensed operators and shift supervisors to be responsible for the operation of the facilities and shall include a table of organization of all personnel provided on each shift.

D. Date of Plant Start-Up: For the purpose of establishing the Contractual requirement date for facilities start-up and operation by the Contractor in water and wastewater facilities, the date on which plant start-up commences shall be the date on which full flow is accepted continuously by the new facilities.

E. Operating Period: The Contractor shall provide required personnel and operate the facilities continuously seven days a week, twenty-four (24) hours per day under full flow conditions with all principal process units functioning for the period required to attain satisfactory performance as defined hereinafter. The Contractor shall continue to operate the facilities after start-up until certificate of acceptance is issued.

F. Operating and Maintenance Personnel: During the operating period the Contractor shall maintain on each shift the required number of operating personnel to properly operate the

plant and safeguard all equipment and appurtenances against damage from whatever cause. As a minimum, the Contractor shall employ for each eight (8) hour daily shift, two (2) Class A operators experienced in the type of equipment and processes involved. An additional Class A operator shall be employed and appointed plant superintendent. The superintendent shall be on-site during the day shift a minimum of five (5) days per week throughout the plant-operating period and shall be on call twenty-four (24) hours per day. All operators and superintendent shall be certified or meet state of Maryland requirements of the Health Occupation Article and Department of Health and Hygiene Regulations. Additionally, mechanical and electrical service and repair personnel shall be available as needed to assure the continuous functions of all equipment and instrumentation.

G. The City shall furnish, at no cost to the Contractor, all electrical power and chemicals needed for any plant operation.

H. Operating Records: The Contractor shall maintain operating, maintenance, and lubrication records and laboratory test results to the Engineer weekly.

01 76 00 PROTECTING INSTALLED CONSTRUCTION

01 76 01 PRESERVATION AND RESTORATION OF PROPERTY, TREES, MONUMENTS, STREAMS, LAKES, AND RESERVOIRS

A. The Contractor shall take all reasonable precautions to prevent pollution of streams, lakes and reservoirs with fuels, oils, bitumens, calcium chloride, silt, sediment or other harmful material. It shall conduct and schedule its operations so as to avoid or minimize siltation of streams, lakes and reservoirs.

B. The Contractor shall not park vehicles or store materials under the canopy of trees without express permission by the Baltimore City Arborist. The Contractor may not damage or remove trees beyond the approved Limit of Disturbance in the Contract Documents. Failure to comply will result in fines as per Article 7, Division IV, Baltimore City Code.

C. The Contractor shall not enter upon private property for any purpose without obtaining permission, and it shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the Work and shall use every precaution necessary to prevent damage or injury to property or persons. It shall use suitable precautions to prevent damage to pipes, conduits, and other underground structures, and shall protect carefully from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location, and shall not remove them until directed. The Contractor shall not willfully nor maliciously injure or destroy trees or shrubs and shall not remove or cut them without proper authority. The Contractor shall be strictly responsible for any and all damage or injury of every kind and description, which directly or indirectly may be done to any property or sustained by any persons during the prosecution of the Work resulting from any wrongdoing, misconduct, want of care or skill, or any negligence of itself, of its agents and/or employees in its manner or method of executing said Work or due to its non-execution of said Work, even though such manner or method of executing said Work or such non-execution of said Work be concurred in, permitted or allowed by the Mayor and City Council of Baltimore, its agents and/or employees, or at any time due to defective Work or materials. When or where any direct or indirect damage or injury is done to public

or private property by or on account of any act, omission, neglect or misconduct in the execution of the Work, or in consequence of the non-execution thereof on the part of the Contractor, the Contractor shall restore, at its own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or it shall make good such damage or injury, rebuild or otherwise restore such property as may be deemed necessary and the cost thereof may be deducted from any monies due or which may become due the Contractor under the Contract.

01 76 02 CONTRACTOR'S RESPONSIBILITY FOR WORK

Until the final acceptance of all the Work as indicated in writing by the Engineer, the Work shall be under the charge of and care of the Contractor and it shall take every precaution against destruction of, injury or damage to the Work or to any part thereof by the action of the elements or from any other cause whatsoever. The Contractor shall rebuild, repair, restore and make good, at its own expense, all destructions of, injuries or damages to the Work or any portion thereof occasioned by any of the above causes before its final completion and acceptance as indicated in writing by the Engineer.

01 76 03 FLOOD AND STORMS

The Contractor's attention is directed to the fact that it shall be solely responsible for any and all damage to the Work caused by floods, storms, floating debris, or other normal or adverse weather, and it shall take every precaution to prevent any damage to the Work which may be caused by floods, storms, floating debris, or other normal or adverse weather.

01 76 04 UTILITIES

A. The Contractor's attention is directed to the fact that there will be no compensation to it for any service fees charged for marking and locating existing utilities. Payment by the Contractor for these service fees will be included in the unit price bid for the various items in this project.

B. It shall be the Contractor's responsibility to support and protect all public utilities such as pipes, conduits and other structures which will remain in place, and in service, during the term of the Contract as indicated on the Plans; also, all others which may be uncovered during construction or which may be installed by others during construction; and to meet all other conditions which may be encountered during the construction. In case of damage to any such pipes, conduits or other structures, the Contractor shall, at its own expense, restore such utilities to a condition equal to that which existed before the damage was done.

1. It is the Contractor's responsibility to pursue collection for any damage incurred by its organization, due to mismarkings by "Miss Utility". The City will not pay any utility damage repairs, delay claims, etc., caused by "Miss Utility" mismarkings. It is the Contractor's responsibility to verify "Miss Utility" markings.
2. It shall be the responsibility of the Contractor to notify the respective utility company when the relocation of existing utilities is required.

3. There are Baltimore Gas and Electric Company and Verizon facilities in the streets. Call "Miss Utility" at least three (3) workdays prior to starting, so that they can arrange to mark the locations of their facilities.
4. Per the Engineer's direction, the Contractor may be required to notify the Baltimore Gas and Electric Company, in order to allow it to conduct a gas leak survey. This notice must be given at least three (3) days in advance.
5. The Contractor must be on the job site to meet the Baltimore Gas and Electric Company representative, when utilities are to be marked.

01 76 05 REMOVAL OF OBSTRUCTIONS

Should the location or position of any gas or water pipe, public or private sewer, conduit or other structure be such as, in the opinion of the Engineer, to require its removal, realignment, or change, such change shall be accomplished without cost to the City. Such structure shall be stripped, exposed or uncovered and supported and sustained by the Contractor, at its own expense, and constituting a part of the Contract, before removal or before and after realignment and change. The Contractor shall not become entitled to claim any damage or extra compensation from or on account of the presence of such structure, or on account of any delay in the removal, realignment or rearrangement of the same; but the Contractor shall be entitled to such an extension of time for the completion of the Contract as the Engineer shall decide that the Work has been delayed, by any delay in the removal, realignment or change of any such obstruction.

01 76 06 PROTECTION, SHIFTING, OR REMOVAL OF STRUCTURES BY OWNERS OF SAME

The Contractor shall not cause any hindrance to, nor interfere with any individual, City department, gas, railroad, street railway, or other company or companies in protecting or repairing its mains, pipes, posts, poles, or other structures, nor in shifting, removing or replacing the same; but the Contractor shall suffer the same individual, City department, gas, railroad, street railway, or other company or companies to take all such measures as they may deem wise or as may become necessary for the purposes aforesaid.

01 76 07 OBSTRUCTIONS

In addition to showing the structures to be built and Work to be done under the Contract, the Plans show certain information obtained by the City regarding pipes, conduits, tracks, and other structures and other conditions, which exist along the lines of the Work, both at and below the surface of the ground. The City expressly disclaims any responsibility for the accuracy or completeness of said information, and the Contractor will not be entitled to any extra compensation on account of inaccuracy or incompleteness of such information, said information being shown only for the convenience of the Contractor, who shall verify the information given to its own satisfaction. If the Contractor, in making up or submitting its Bid, relies upon said information, it does so at its own risk. The giving of this information on the Contract Drawings will not relieve the Contractor of its obligations to support and protect all pipes, conduits, tracks and other.

01 77 00 CLOSEOUT PROCEDURES

01 77 16 FINAL INSPECTION

Final inspection of all Work, appurtenances, or other structures built under the Contract will be made under the supervision of and in such manner as directed by the Engineer. The Contractor shall furnish all appliances and all materials and labor, which may be required for such inspections. No compensation will be made to the Contractor for any labor, tools, or appliances, which may be used or expended in such inspections.

01 77 17 FINAL ACCEPTANCE

A. Whenever, in the opinion of the Engineer, the Contractor has completed the entire Work or a specific phase or portion of the Work in an acceptable manner in accordance with the terms of the Contract, the Engineer shall make an inspection of the entire Work or such specific phase or portion of the Work, and upon completion of all repairs or renewals which may appear at that time to be necessary, in the judgment of the Engineer, they shall certify to the City as to said completion of the Work in its entirety or as to the value thereof. The aforesaid certificate shall be held and taken to be evidence of the Conditional Acceptance of the entire Work, or of such phases or portions of the Work, by the City as of the date thereof. Notwithstanding the issuance of such certificate and the Conditional Acceptance of the entire Work, phase or portion thereof, the City shall reserve and retain for and during the maintenance period described herein as stipulated under 01 29 78, "Application of Monies Retained" in this section above all other reservations and/or deductions which the City is, by the terms of the Contract Documents, or otherwise entitled, or required to make and retain.

B. Unless otherwise stipulated in the Contract Documents, the maintenance period shall be of twelve (12) months duration from and after the date of said certificate of Conditional Acceptance.

C. The Engineer reserves the right to conduct one (1) interim operational progress inspection at the approximate midpoint of the maintenance or warranty periods specified within the Contract Documents. In addition, final inspection will be conducted at the end of the maintenance or warranty periods specified within the Contract Documents.

D. At such inspections, upon the direction of the Engineer, the Contractor shall demonstrate and certify as to correct operation of any or all components or systems of the project, in accordance with the Specifications for each respective part of the project. At such inspections, the Contractor shall arrange for the presence of representatives of Subcontractors, suppliers, manufacturers, etc., in order that personnel having the appropriate expertise may be available, for the purpose of demonstrating such correct and proper operation of the project's components and systems.

E. The Engineer reserves the right to generate a punch list, at any such mid-term or final inspection. The Engineer reserves the right to impose a period of time, not fewer than thirty (30) days, in which the Contractor shall correct all items listed within any such punch list. Failure of the Contractor to take corrective action specified within any such punch list, within the times specified, shall be additional grounds for assessment of liquidated damages specified in 00 73 83 "Failure to Complete Work on Time and Liquidated

Damages". Assessment of liquidated damages in such instances does not impair the Engineer's right to pursue any other remedies set forth within the Contract Documents, or allowed under Maryland law.

F. Contractor shall bear all costs and expenses of any kind required for the purposes above mentioned.

G. Prior to the end of the warranty and guarantee period specified, the Engineer will make a Final Inspection of the Work to determine the status of all equipment, structures, systems and other Work in regards to warranty and guarantee provisions. The Contractor will be notified in writing of all repairs, and renewals required, and will be given a specified time in which to perform such Work. Upon successful completion of all such repairs and renewals, as determined by the Engineer, the City will issue a certificate of Final Acceptance of the Work.

01 77 20 LAST PAYMENT TO TERMINATE LIABILITY OF THE CITY

The acceptance by the Contractor of the final payment made shall serve as a release to the City and every agent thereof from all claims and liabilities to the Contractor for anything done or furnished for or in any way relating to the Work, or for any act or neglect of the City or of any person relating to or affecting this Work. Final payment cannot take place until the completion of all punch list Work generated as a result of the Final Inspection discussed in 01 77 17, G.

01 77 21 EVIDENCE OF PAYMENT FOR LABOR AND MATERIALS

When written notice is given to the Engineer before or within ten (10) days after the completion of the entire Work under the Contract, by persons having done Work or furnished materials for such Contract, that there is money due and unpaid for said Work, and materials, the Contractor shall furnish the Engineer satisfactory evidence that said money has been fully paid or satisfactorily secured by it. And in case such evidence is not furnished as aforesaid, such amount as may be necessary to meet the claims of the persons aforesaid may be retained from any monies due the Contractor under the Contract until the liabilities aforesaid shall be fully discharged or such notice withdrawn. The City or the Engineer may also, with the written consent of the Contractor, use any money retained, due or to become due under the Contract, for the purpose of paying for both labor and material for the Work for which claims have been filed in the office of the Engineer.

01 78 00 CLOSEOUT SUBMITTALS

01 78 23 OPERATION AND MAINTENANCE DATA

A. The Contractor shall furnish three (3) copies of all final operation and maintenance manuals as well as a readable, scanned copy on CD-ROM in Microsoft Word for Microsoft Office or PDF files, for all products and equipment identified in the manual.

B. Prior to completion of the Work, and at least thirty (30) days prior to the fifty percent (50%) payment request, the Contractor shall furnish for the Engineer's review three (3) operation and maintenance manual draft copies.

C. Prior to completion of the Work, and at least sixty (60) days prior to the eighty-five percent (85%) payment request, the Contractor shall furnish for the Engineer's review five (5) copies of the final operation and maintenance manuals. The final manual must be approved by the Engineer before a final inspection of the Work will be conducted and prior to the issuance of the certificate of acceptance. O&M manuals must be received prior to training, to be used as part of classroom sessions.

D. Manuals shall include operation and maintenance information on all systems and items of equipment. Equipment that will function as part of a system shall have the data assembled in such a manner that describes the operation and maintenance of the entire system. The data shall consist of catalogs, brochures, bulletins, charts, schedules, approved shop drawings corrected to as-built conditions and assembly Drawings and wiring diagrams describing location, operation, maintenance, lubrication, operating weight, lubrication chart and schedules showing manufacturer recommended lubricants for each rotating or reciprocating unit, and other information necessary for the City to establish an effective operating and maintenance program. The following data shall also be included in each manual.

E. Title page giving owner's name, Contract number, and location of facility. An index shall follow, listing the division of topics contained within the document. Divisions shall be sorted by system or equipment type. Each division shall have an index tab.

1. Equipment name, location and number of units.
2. Manufacturer's name, address and telephone number.
3. Name, address and phone number of the nearest certified manufacturer's representative.
4. Nameplate data for basic unit as well as components such as drive and motor.
5. Performance curves for all pump and equipment.
6. Approved shop drawing of each piece of equipment.
7. Manufacturer's cuts and dimension Drawings of each piece of equipment and details of all replacement parts.
8. Complete wiring diagrams of all individual pieces of equipment and systems including one line diagrams, schematic or elementary diagrams, and interconnection and terminal board identification diagrams.
9. Complete piping and interconnecting Drawings.
10. Complete parts list with parts assembly Drawing (preferably by exploded view), names and addresses of spare parts suppliers, recommended list of spare parts to be kept "in stock" and sample order forms for ordering spare parts. Lead time required for ordering parts shall be estimated. A list of any special tools required for maintenance.
11. Instructions with easily understood schematics or diagrams for disassembling and assembling the equipment for overhaul or repair.
12. Detailed written procedures to be used for all modes of operation including any precautions for personal safety or for prevention of damage to the equipment (mechanical or electrical). This includes initial start-up, interim operation when necessary, normal operation, emergency operation, shutdown and restarting. Required operating checks, calibration and field performance measurements shall be described.
13. Guides for testing and troubleshooting; these shall include a chart giving symptoms, probable cause and remedies.

14. A lubricating schedule showing lubrication point, frequency and recommended lubricant including one or more major brand alternates. Lubrication schedules shall include recommendation for periods when equipment is in standby or storage.
15. Recommended preventive maintenance measures and frequency of performance. Each recommended maintenance measure shall be described in terms of procedures, tools, parts, materials or test equipment necessary to perform the procedures and safety precautions to be presented utilizing the format shown in the attached maintenance procedure sheet.
16. A copy of all manufacturers' certificates shall be bound in each operation and maintenance manual.

F. The Contractor shall complete the three (3) City forms; Form A – "Equipment Registration", Form B – "Parts Sheet", and Form C – "Maintenance Procedure Sheet" for each type of equipment furnished under the Contract. The completely approved registration cards and procedure sheets must be submitted at least ninety (90) days prior to start of warranty and/or completion of construction. For start of warranty and guarantee, refer to 01 77 17, "Final Acceptance". These forms shall be included in the operations and maintenance manual at the proper place.

G. All items listed above that are of a sheet size of eight and one-half inches by eleven inches (8-1/2″ X 11″) or can be folded (no more than twice) to this size shall be bound in loose-leaf three ring type binders with black plastic-coated or blue canvas covers. The contents shall be fully indexed. Binders shall be Vernon Line Royal No. R-6372 or R-372 or equal. Pages shall be linen reinforced on binding edge.

H. Shop drawings twenty-four inches by thirty-six inches (24″ X 36″) in size shall be folded to approximately twelve inches by nine inches (12″ X 9″) with Drawing title box exposed along either edge. Shop drawings descriptive of a single item of equipment shall be grouped together. All shop drawings shall be placed in accordion type folders nine inches by fourteen inches (9″ X 14″). Clear, vinyl top-loading sheet protectors, such as No. 61013, as manufactured by C-Line Products, Inc., or equal, may be substituted for the accordion type folders.

I. All shop drawings included in the binders and/or folders shall be those copies previously submitted for review and approval and shall bear the Engineer's stamp of approval and comments as originally noted thereon.

1. Subsequent to the Engineer's approval and return of the final manual, the Contractor shall submit five (5) complete sets of manuals for distribution by the Engineer.
2. Conditional Acceptance and/or beneficial occupancy will positively not be undertaken until approved operation and maintenance manuals have been submitted.

J. Delivery of all manufacturers' service (O&M) manuals and installation instructions satisfactory to the Engineer is an essential part of the equipment delivery to meet EPA requirements. These requirements are published in the federal regulations for the preparation of an O&M manual and prerequisite to approval of final payment on the delivery of that equipment. Incomplete and inadequate manuals will be returned to the Contractor for correction and/or resubmission.

01 78 24 MANUFACTURER'S CERTIFICATES

A. GENERAL

1. As part of furnishing certain items of equipment and systems specified herein, the Contractor shall secure from the manufacturers of the equipment and systems, and submit to the Engineer for approval, three (3) separate certifications, certifying that the manufacturer approves the equipment for the use intended, that it conforms to the requirements of the Specifications, that it has been installed, tested and operated to the satisfaction of the manufacturer, and that it meets the performance requirements of the Specifications.
2. A statement originating from the Contractor, or any of its Subcontractors, suppliers, or any other agent, which merely indicates that a particular item of equipment or system meets the requirements of the Contract Documents, shall not be considered a certificate. Any such submittal made in this manner will not be approved and the corresponding equipment or system shall not be finally accepted.
3. All costs associated with the furnishing of these certifications shall be included in the prices bid for furnishing the equipment or systems.
4. It is recognized that equipment and systems specified herein may be comprised of various components of different manufacturers (e.g., sluice gates and motor operators, etc.). It is intended insofar as possible that for purposes of executing the manufacturer's certifications, a single point of responsibility will be established for each item or system, and that this point of responsibility will be the manufacturer of the major equipment component (e.g., motor, sluice gate,), and that this manufacturer will be able to secure sufficient assurance from component manufacturers to permit it to execute the manufacturer's certifications on behalf of its equipment and that of the other component manufacturers. If the major equipment component's manufacturer is unwilling, or unable, to assume the responsibility of executing the manufacturers certifications for the entire item of equipment or system specified, then the Contractor shall provide certifications from each component manufacturer.

B. MANUFACTURER'S REPRESENTATIVE

1. The definition of "manufacturer's representative" shall be as follows: a representative from the manufacturer's plant, familiar with the actual problems of manufacturing, installing and operating the particular equipment or product and with enough years of experience in this field to determine the successful operation of the equipment or product. Sales representatives or agents of the manufacturers will not be acceptable.
2. As related to its obtaining the manufacturer's certificates, the Contractor shall include in the Contract Price the cost of furnishing competent and experienced manufacturer's representatives who shall represent the manufacturer of equipment and products furnished and installed, to assist the Contractor to install, adjust, start up, and test the equipment and products in conformity with the Contract Documents. After the equipment and products have been initially operated and before being put into permanent service by the Engineer, such manufacturer's representatives shall make all adjustments and tests required to prove that such equipment and products are in proper and satisfactory operating condition, and meet the requirements for issuing the manufacturer's certificate.

C. MANUFACTURER'S EQUIPMENT CERTIFICATION

At the time of submitting shop drawings, submit a certification, on the form provided in this section, entitled "Equipment Certification Form", from each manufacturer of the equipment or system listed herein attesting that the manufacturer has examined the Contract Drawings and Specifications and that the proposed equipment, component, or system meets or exceeds Contract Specifications, is suitable for its intended purpose and installation, and will provide satisfactory performance at the design criteria specified.

D. EQUIPMENT INSTALLATION CERTIFICATION

Prior to start-up, run-in and operation, submit a certification, in the form provided herein entitled "Equipment Installation Certification Form" from each manufacturer of the equipment or system listed herein attesting that the manufacturer has examined the field installation of the equipment or system, and it has been properly installed and lubricated under either the continuous or periodic supervision of the manufacturer's representative, is in accurate alignment; is free from undue stress imposed by connecting piping or anchor bolts; has been installed in accordance with the Contract Drawings and Specifications, approved shop drawings and product data including any notations, remarks, or revisions by the Engineer, to the manufacturer's satisfaction.

E. EQUIPMENT OPERATION WARRANTY

At the conclusion of the running-in period, submit a certification, in the form provided herein entitled "Equipment Operation Warranty" from each manufacturer of the equipment or system listed herein that the equipment, component or system furnished, has been properly installed and lubricated under either the continuous or periodic supervision of the manufacturer's representative, is in accurate alignment; is free from undue stress imposed by connecting piping or anchor bolts; has been adjusted and initially operated under full load conditions in the presence of the manufacturer's field representative and that it operated satisfactorily, in accordance with the Contract Drawings and Specifications, approved shop drawings and product data including any notations, remarks, or revisions by the Engineer, to the manufacturer's satisfaction.

01 78 36 WARRANTIES

A. The Contractor warrants and guarantees to the City all the improvements made for a period of one (1) year, unless otherwise specified in the Contract Documents, after the date of acceptance or occupancy by the City the following:

B. That all materials and equipment provided will be new, unless otherwise specified.

C. That all Work will be of good quality and free from faults and defects and in accordance with the requirements of the Contract Documents.

D. That all equipment and systems and each and every part thereof, shall operate (with proper care and attention) in a satisfactory and efficient manner, and in accordance with the Contract Documents.

E. That every structure and building shall be watertight and leak proof, as specified in the Contract Documents.

F. That the Contractor shall, upon receipt of written notice from the City, replace with proper workmanship and materials, and re-execute, correct or repair, without cost to the City, all Work which may be found to be not in accordance with the Contract Documents.

G. That the guarantee obligations assumed by the Contractor under these Contract Documents shall not be held or taken to be in any way impaired because of the Specifications, indication or approval by or on behalf of the City of any articles, materials, means, combinations or things used or to be used in the construction, performance and completion of the Work, or any part thereof.

H. That no use or acceptance by the City of the Work or any part thereof, nor any failure to use the same, nor any repairs, adjustments or corrections made by the City due to the Contractor's failure to comply with any of its obligations under the Contract Documents, shall impair in any way the guarantee obligations assumed by the Contract or under these Contract Documents.

I. If the Contractor neglects to make such repairs during the guarantee period, the City may cause such damage or defective Work to be repaired and made good at the cost and expense of the Contractor, including compensation if required for additional professional services. The Contractor shall also bear the expenses of making good all Work of others destroyed or damaged by its correction, removal or replacement of the defective Work.

J. The Contractor shall maintain the performance bond for the project in full force throughout the entire guarantee period, until Final Acceptance is made. The Contractor shall furnish proof upon request of the City that the bond is in full force, including proof of premium payments.

K. All equipment, systems and other Work shall be fully operational at the beginning of the guarantee period. Upon determination by the Engineer that an item of Work is defective, the City will notify the Contractor in writing of the existence and extent of such defect, and shall establish a reasonable time for the Contractor to inspect, renew or repair the item of Work. If the Contractor satisfactorily renews or repairs the item within the stipulated time period, the guarantee period will be unaffected. If the Contractor fails to satisfactorily renew or repair the defective item within the stipulated time period, the guarantee and warranty period shall be extended by the amount of time beyond the stipulated time period until the item is fully and satisfactorily operational. The intent of this requirement is that the City receives full and satisfactory use of all items of Work for the full guarantee period.

01 78 39 PROJECT RECORDS DOCUMENTS

A. Upon successful completion of the improvements and prior to facility operational start up and testing, the Contractor shall certify to the City in writing that the Work is complete and request that the City issue a certificate for acceptance of the Work. This certification shall be accompanied by equipment operation warranty as described in 01 78 24, “Manufacturer's Certificates” in this section.

B. Prior to requesting such a certificate, construction and installation of all equipment relating to the performance evaluation facility construction shall be complete and all individual systems testing shall have been performed to fully comply with the specified requirements of the Contract Documents. All specified operation and maintenance instructions and training shall have been provided for the City personnel.

C. Within a reasonable time after request of the certificate, the City, the Contractor and the Engineer will make an inspection of the Work to determine the status of completion. At this time the Contractor shall furnish to the City, complete test data and operation and maintenance manuals, if it has not already done so.

D. If the City and the Engineer do not consider the Work to be complete, the City will notify the Contractor in writing of this fact, and will include the reasons why the Work is not considered complete. However, if the City and the Engineer consider the Work to be complete, the City will prepare and deliver to the Contractor a certificate of acceptance, which shall fix the date of completion for that Work and shall define the responsibilities of the City and the Contractor for maintenance and operation of the facility during the operational start up and testing period.

E. The City shall have the right to exclude the Contractor from the project after the date of successful completion of the facility's operational start up and testing period, but the City will allow the Contractor reasonable access to perform Work required by the guarantee. Inspection of the Work leading to Conditional Acceptance and commencement of the guarantee herein stipulated will positively not be made on any interim or partial basis except as specified in 01 78 36, "Warranties" of this section, nor will guarantee obligations of the Contractor relate to, or bear upon in any manner, the warranty or warranty limits arranged between the Contractor and its suppliers. The City will positively not commence maintenance of equipment and system until acceptance of the entire Work area has been made. It is, therefore, incumbent upon the Contractor to arrange for service Contracts and extended warranties or guarantees of the extent and duration it deems necessary and requisite, to protect its interests through the date of Final Acceptance and to include the cost of the same in the price Bid.

DIVISION 02
EXISTING CONDITIONS
02 20 00 ASSESSMENT

02 20 01 CONSTRUCTION STAKEOUT

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing, placing and maintaining construction layout stakes as specified in the Contract Documents or as directed by the Engineer.

B. The Contractor shall, as part of the construction stakeout operation, before any clearing operation commences, demarcate any wetlands and the limit of clearing throughout the entire project as shown in the Contract Documents and labeled as limit of clearing or wetlands to the satisfaction of the Engineer.

C. Where limits of clearing are not shown in the Contract Documents, the limit of clearing will be the top of cut, toe of slope or limit of ditch excavation.

PART 2 PRODUCTS

2.1 MATERIALS

The material for flagging the clearing limits shall be a three inch (3″) international orange vinyl material with “CLEARING LIMIT” printed on it with two inch (2″) letters. The material for flagging wetlands shall be the standard one and one-half inch (1-1/2″) pink and white striped vinyl flagging with “WETLAND” printed on it with blue letters.

PART 3 EXECUTION

3.1 LINE AND GRADE

A. The Engineer will provide the Contractor the following:

1. Roadway Stakeout.

   a. A staked centerline of the roadway with the maximum spacing of stations (stakes, nails, crosses, etc.) every one hundred feet (100′).
   b. Establish appropriately spaced benchmarks and the necessary references including all points of curvature (P.C.), and points of tangency (P.T.) for the preservation and control of the centerline.
   c. Two (2) sets of prints of the cross sections. The cross sections shall be used as guides only. Dimensions or elevations scaled from the cross sections are not sufficiently precise for use in the construction.

2. Structure Stakeout.

   a. A staked-out center line or working line, whichever applies, with stations not over one hundred feet (100′) apart and extending at least one hundred

feet (100′) beyond the ends of the structure. When the structure is on a curve, the Engineer will furnish a staked-out centerline or working line, whichever applies, consisting of stations not over one hundred feet (100′) apart and including the points of curvature and points of tangency and at least one (1) point on the tangents beyond each end of the curve.

b. At least two (2) benchmarks, one (1) on each end of the structure, will be established by the Engineer.

3.2 EQUIPMENT AND PERSONNEL

The Contractor shall use competent personnel and state of the art equipment for all engineering Work required to set and maintain the elevations and dimensions as specified in the Contract Documents.

3.3 CONTROL MARKERS

The Contractor shall be responsible for preserving the centerline and benchmarks set by the Engineer. When the centerline and benchmarks are disturbed or destroyed, they shall be replaced by the Contractor at no additional cost to the City.

3.4 CONTROL STAKES

For roadways as specified in paragraph 3.1, A, 1, titled "Roadway Stakeout", the Contractor shall furnish, set and preserve stakes at each station along each side of the project on the right-of-way or easement line, whichever is furthest from the center line of construction. Where only part of an ultimate dual highway is to be constructed, the stakes on the side of the future improvement shall be set ten feet (10′) beyond the construction limits. On each of these stakes shall be marked its offset distance from the centerline and its top elevation or the cut or fill to the profile grade line. Additional stakes as needed for horizontal and vertical controls necessary for the correct layout of the Work shall be set by the Contractor.

3.5 LAYOUT

A. For structures as specified in paragraph 3.1, A, 2, titled "Structure Stakeout", the Contractor shall proceed with the layout Work. However, before any actual construction begins, the Contractor shall rerun and check the Engineer's lines and grades and then establish all centerline or working line intersections with the centerline or center of bearing of all piers, bents and abutments. From these field layouts, the Contractor shall check the proposed span lengths by electronic distance measurement or chaining. When chaining is used, the measurements shall be compensated for temperature, sag, and horizontal alignment. The Contractor shall also check the location of the structure to affirm its correct location with relation to existing structures, roads, and existing conditions that are to remain in their original positions. If any discrepancies are found, the Contractor shall notify the Engineer at once in writing, otherwise, it will be assumed that all planned dimensions, grades and field measurements are correct. All lines established on the ground shall be preserved or referenced, marked, and kept available at all times.

B. The Contractor shall establish the field elevations for all bridge seats and assume responsibility for finishing to proper grade. If any steel beams or girders are incorporated in the project, the Contractor shall run elevations over the tops of the beams or girders

after they are in place, before any forms are attached to them, to determine the deflection of each member. This information shall then be applied to the deflection diagram to determine the corrected elevation of bottom slab forms and screed supports. After the Contractor has assembled this information, it will be checked by the Engineer before final adjustments are made and the placing of any concrete in the forms.

3.6 UTILITIES

A. The Contractor shall furnish to the utility companies or agencies working within the limits of the project, promptly upon request, reference to control points, alignment and grade data, so that they may properly locate and coordinate their Work and improvements in relation to the project.

B. Intersection Utility Stakeout. The Contractor shall notify the appropriate agencies a minimum of seventy-two (72) hours (excluding weekends and holidays) prior to the Contractor's anticipated beginning of any underground Work.

1. Request a utility stakeout and possess a valid utility clearance ticket number for any underground Work.
2. Contact all utilities within the limits of the project that are not a member of "Miss Utility" and obtain a stakeout of their respective facilities.
3. Request the Engineer to stakeout City maintained traffic signal facilities.
4. Request the Engineer to stakeout the lighting facilities.

C. The Contractor shall stakeout the proposed construction as indicated in the Contract Documents and allow the Engineer to verify location of the proposed facilities.

3.7 SUBGRADE, SUBBASE AND BASE CONTROLS

A. The Contractor shall furnish for subgrade, subbase and base courses, a string line and grade with fixed controls having a maximum longitudinal and transverse spacing of twenty-five feet (25′).

B. The Contractor shall place along each form line for cement concrete pavement line and grade with fixed controls not to exceed twenty-five feet (25′).

3.8 FLAGGING

A. The flagging shall be placed continuously through wetland areas. In areas where trees are not to be disturbed, the Contractor shall individually flag those trees in a line along the clearing limits that are not to be moved or destroyed. If the clearing or wetland flagging has been destroyed and the Engineer determines that its use is still required, the Contractor shall reflag the areas.

B. If the Contractor does not replace destroyed flagging within forty-eight (48) hours after notification by the Engineer that replacement flagging is needed, the Engineer may proceed to have the area reflagged. The cost of the reflagging by the Engineer will be charged to the Contractor and deducted from any monies due under the Contract.

C. At the completion of construction, the Contractor shall remove all flagging.

PART 4 MEASUREMENT AND PAYMENT

Construction Stakeout will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for furnishing, placing and maintaining construction layout stakes, flagging of clearing limits and wetlands, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. Payment of the Contract lump sum price will be prorated and paid in equal amounts on each monthly estimate. The number of months used for prorating will be the number estimated to complete the Work.

02 32 00 GEOTECHNICAL INVESTIGATIONS

02 32 13 SUBSURFACE DRILLING AND SAMPLING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of drilling test holes in rock or other foundation material as a means of verifying the character and suitability of material for foundation purposes.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. Test holes shall be drilled in conformance with American Association of State Highway and Transportation Officials (AASHTO) Testing Methods T 206 and T 225 and shall be drilled at least ten (10) working days prior to excavation or pile driving in that area. The Contractor shall notify the Engineer at least ten (10) working days prior to drilling. The locations and minimum depth of the test holes shall be as specified in the Contract Documents or as directed by the Engineer. The Contractor shall record all information on the boring log form approved by the Engineer. The Contractor shall supply a geologist approved by the Engineer or a geotechnical Engineer that is a professional Engineer registered in the State of Maryland to ensure that the test holes conform to these Specifications.

B. The geologist/geotechnical Engineer shall submit the drilling results to the Engineer within two (2) working days after drilling any given hole or as specified in the Contract Documents. The Engineer will evaluate the subfoundation investigation to determine if any change in the planned excavation is necessary. Foundation excavation will not be permitted until the Contractor receives the Engineer's evaluation for that particular foundation.

PART 4 MEASUREMENT AND PAYMENT

Subsurface drilling will be measured and paid for at the Contract Unit Price per linear foot for the actual total length of holes drilled. The payment will be full compensation for the

geologist or geotechnical engineering services, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

00 41 00 DEMOLITION

02 41 13.13 PAVING REMOVAL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of milling the hot mix asphalt (HMA) pavement to the depth and locations specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Hot Mix Asphalt (HMA) 32 12 16.13, (Plant Mix Asphalt Pavement).

PART 3 EXECUTION

A. Roadway patching shall be performed before the milling operation. Additional roadway patching may be required after the milling operation to correct pavement defects made visible by the milling operation. Refer to 32 01 17.59, (Hot Mix Asphalt Patch).

B. Equipment: The machine for removing the asphalt pavement shall be a power operated planing machine or grinder capable of removing, in one (1) pass, a layer of asphalt pavement not less than half the lane width to be removed. The machine shall be capable of accurately establishing profile grade control and shall have positive means for controlling slope elevation. The resultant surface shall be true to the established grade and shall be skid resistant. Unless otherwise directed by the Engineer, a tolerance of plus or minus one-eighth inch (± 1/8″) when using a ten foot (10′) straightedge supplied by the Contractor shall be maintained. The machine shall be capable of preventing dust from escaping into the atmosphere.

C. Pavement Milling: The milling operation shall be performed in only one (1) lane at a time. When milling highways carrying traffic, all milling exceeding two and one-half inches (2-1/2″) shall have the abutting lane or shoulder milled on the same day. When milling to a depth of two and one-half inches (2-1/2″) or less, the Contractor has the option of milling the abutting lane or shoulder on alternate days. The abutting lane or shoulder shall be milled regardless of depth prior to weekends or temporary shutdowns. Where uneven pavement joints exist, the Contractor shall provide adequate advance warning traffic control devices in conformance with the Contract Documents.

D. Temporary pavement tie-ins shall be constructed a minimum of four feet (4′) in length for each one inch (1″) of milling depth.

E. In addition to any other equipment required to remove debris due to the milling operation, a street sweeper equipped with a vacuum shall be used to remove the dust prior to returning the area to traffic.

F. After the milling operation is complete, all depressions, potholes, and other irregularities shall be filled and any existing water valves, meters, manhole covers, etc., shall be wedged using HMA.

PART 4 MEASUREMENT AND PAYMENT

A. Milling Hot Mix Asphalt Pavement will be measured and paid for at the Contract Unit Price per square yard. The square yard measurement will be computed from the actual width and length measurements of the area that has been milled. The payment will be full compensation for milling, the disposal of milled material, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Filling depressions and potholes, and wedging manholes, valves boxes, inlets, or other structures, using hot mix asphalt will be measured and paid for as Hot Mix Asphalt Patches at the Contract Unit Price per ton. The payment will be full compensation for all tack coat, crack filler, hauling, placing, compacting, maintaining, removal, rehandling, reworking and disposal, and also for all material, labor, equipment, tools, and incidentals necessary to complete the Work. When hot mix asphalt is part of any base or pavement course used for the construction and maintenance of temporary detours, approaches, crossings, and widenings, the item of Work will be measured and paid for in conformance with 32 12 16.

C. Hot Mix Asphalt Patches will be measured and paid for as specified in 32 01 19.59, (Hot Mix Asphalt Patch).

02 41 13.14 MINOR SELECTIVE SITE DEMOLITION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of removing all or part of existing concrete, concrete block, brick or stone structures (headwalls, toe walls, etc.), including concrete piles as specified in the Contract Documents or all such masonry as may interfere with new Work or as directed by the Engineer. Removal of existing bridge structures shall conform to 02 41 16.33, (Bridge Demolition and Disposal).

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 REMOVAL

A. All removal shall be to an elevation of at least one foot (1') below subgrade or existing ground, unless otherwise specified in the Contract Documents or as directed by the Engineer. Blasting will not be permitted without the written approval of the Engineer.

B. Piles, grillages, or cribbing under removed masonry shall be cut off and removed to the above limits unless they will not affect the design of new Work, in which event, they may be left in place as directed by the Engineer.

3.2 USE OF REMOVED MASONRY

A. Masonry material may be broken and used in the embankment Work. The broken material will be considered as rock provided that individual pieces do not exceed twenty-four inches (24") in any dimension. Larger size rocks may be wasted with the approval of the Engineer.

B. All materials having salvage value shall be incorporated in the Work, or stored within the limits of the project as indicated on the Contract Document or as directed by the Engineer.

C. Materials determined to be unsuitable by the Engineer shall be disposed of as excess or unsuitable material at no additional cost to the City.

3.3 PROTECTION OF RETAINED MASONRY

Retained sections that are damaged due to the Contractor's operations as determined by the Engineer shall be repaired or replaced in a manner acceptable to the Engineer at the sole expense of the Contractor. Connecting edges and surfaces shall be cut to lines specified in the Contract Documents or as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, backfill, disposal of excess or unsuitable material, blasting, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Removal of existing masonry will not be measured but will be included in the Contract lump sum price.

C. When specified in the Contract Documents, removal of existing masonry will be measured and paid for at the Contract Unit Price per cubic yard based on the volume of masonry actually removed and calculated by the method of average end areas.

D. As old masonry is frequently of irregular or unknown dimensions, Contractor and Engineer shall agree upon the dimensions as cross sections are taken. No measurement will be made for isolated piles of materials after same has been removed from its original position.

E. No measurement will be made for excavation necessary for access to remove the masonry unless said excavation occurs within the normal limits for structure excavation.

F. When a new structure is placed in the location of an existing structure, the removal of the existing structure will be incidental to the new structure unless otherwise specified.

02 41 13.16 REMOVAL OF EXISTING PAVEMENT, SIDEWALK, PAVED DITCHES, CURB, OR COMBINATION CURB AND GUTTER

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the full depth removal and disposal of existing pavement, sidewalk, paved ditches, and curb or combination curb and gutter as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 FULL DEPTH SAW CUT

The Contractor shall full depth saw cut the existing pavement, sidewalk, paved ditches, curb or combination curb and gutter along the lines specified in the Contract Documents or as directed by the Engineer.

3.2 USE OF REMOVED PAVEMENT, SIDEWALK, PAVED DITCHES, CURB OR COMBINATION CURB AND GUTTER

Removed materials may be broken and used in the Work with the approval of the Engineer. The broken material shall be considered as rock provided that individual pieces do not exceed twenty-four inches (24″) in any dimension. Larger size rocks may be wasted with the approval of the Engineer.

3.3 PROTECTION OF RETAINED PAVEMENT, SIDEWALK, PAVED DITCHES, CURB OR COMBINATION CURB AND GUTTER

The Contractor shall not damage sections that are not to be removed. Damage done by the Contractor to those areas to remain in place shall be repaired or replaced at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all Work specified regardless of the type or depth of material removed and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Removal of existing pavement, sidewalk, paved ditches, curb or combination curb and gutter, and full depth saw cuts within the limits of any class of excavation will not be measured but the cost will be incidental to the Contract Unit Price for the class of excavation in which it occurs.

C. When the existing sidewalk is removed and replaced with a new sidewalk, the cost to remove the existing sidewalk will be incidental to the Contract Unit Price for sidewalk.

D. Saw cuts, removal of existing pavement, sidewalk, paved ditches, and curb or combination curb and gutter outside the limits of any class of excavation will be measured in the original position and paid for as follows:

1. Saw cuts per linear foot when specified in the Contract Documents.
2. Removal of existing pavement, sidewalk, and paved ditches per cubic yard.
3. Removal of existing curb or combination curb and gutter per linear foot.

E. When any material included in PART 4, D, (2) or D, (3) above, is removed but not replaced, the area shall be backfilled and landscaped as directed by the Engineer. All costs will be incidental to the Contract Unit Price for the pertinent items specified in the Contract Documents.

02 41 16.13 BUILDING DEMOLITION AND DISPOSAL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the removal and disposal of existing buildings, including foundations, footings or any part thereof, and backfilling, as specified in the Contract Documents. The Work also includes protection of the buildings until the removal and disposal are completed as directed by the Engineer. Locations of buildings included in the Work will be designated in the Contract Documents by the circled numbers, etc.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. The Contractor shall schedule the buildings and appurtenances for removal, razing, or evacuation as one of the first items of Work.

B. Any building used by the Contractor for purposes such as field office, storage, etc., may remain as an exception to the above but shall be removed and disposed of immediately when vacated.

C. Buildings and appurtenances designated for removal may be disposed of by burning if they are not located close to inhabitable dwellings and if not prohibited by local or state laws, regulations, ordinances, or by the fire marshal.

D. Salvaged materials shall become the property of the Contractor. When materials are sold by the Contractor and are removed by the purchaser, it shall be done only during daylight working hours and in company with a Contractor's representative.

E. The Contractor shall be responsible for posting and protecting the buildings from vandalism or theft until they are removed.

PART 4 MEASUREMENT AND PAYMENT

A. Removal and disposal of existing buildings will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. All buildings not designated for removal and disposal in the Contract Documents will not be measured but the cost will be incidental to 31 11 00, (Clearing and Grubbing).

C. The City reserves the right to eliminate from this item any or all buildings or structures. For each building eliminated from this item, the item will be credited to the extent of the cost eliminated, which will be determined from a breakdown submitted by the Contractor showing the tabulation of individual unit costs used in arriving at the Contract Price for this item. A breakdown of the Contract lump sum price for removal and disposal of existing buildings shall be submitted to the Engineer prior to beginning Work.

02 41 16.33 BRIDGE DEMOLITION

PART 1 GENERAL

1.1 Description

This Work shall consist of removal and disposal or salvage, wholly or in part, of existing structures in accordance with these Specifications and in reasonably close conformity with the lines, grades, and details shown on the Plans or as established by the Engineer.

PART 2 PRODUCTS

1.2 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 PROCEDURES

A. Before removal operations begin, the Contractor shall submit to the Engineer for approval, a list of the equipment to be used and the removal method.

B. The design of sheeting and shoring required for the removal of existing structures, or portions thereof, shall be the responsibility of the Contractor. The Contractor shall submit the details, procedure, and design computations of sheeting and shoring system signed and sealed by the Engineer licensed in the State of Maryland for Engineer's review and approval.

C. DISMANTLING STRUCTURES FOR RETENTION BY CONTRACTOR

1. Dismantling and removing existing structure shall include removing the entire Superstructure, Substructure, and slope protection. The Substructure shall be removed down to the streambed or to an elevation of at least two feet (2′) below the natural ground or finished grade of embankment that is to remain in place. Removal shall include any part of the Substructure or foundation piling that will interfere with the new construction.
2. When dismantling Structures for retention by Contractor removed materials shall become the property of the Contractor and shall be removed from the project. The Contractor shall assume all personal and property liability associated with such materials and shall protect and save harmless the City from any and all damages and claims associated with the handling, transportation, storage or use of such materials. The City does not warrant the condition or the physical or chemical characteristics of the materials.

D. DISMANTLING STRUCTURES FOR RETENTION BY BALTIMORE CITY

Dismantling structures for retention by Baltimore City shall be in accordance with a method approved by the Engineer and shall be such as to preserve the existing condition of materials. Units shall be match marked and stored as directed by the Engineer.

1. Removing Portions of Existing Structure

   a. The portions to be removed shall be the areas designated on the Plans. Concrete shall not be removed by blasting or other methods that may damage concrete or reinforcement that will remain in the completed structure. The weight of pneumatic hammers shall be not more than ninety (90) pounds for widening Work or thirty (30) pounds for deck repair Work. The use of tractor mounted demolition hammers will not be permitted.

      1) Disturbed areas shall be uniformly graded to natural ground contours in a manner that will facilitate drainage and prevent impoundment of water.

   b. When portions of an existing Structure are to be removed and the remaining portion will be exposed to view in the final Structure, a neat one inch (1″) deep saw cut shall be made to separate the removal operations from the concrete that is to remain. Existing reinforcement steel that will be incorporated into the final Structure shall be straightened and cleaned. Care shall be taken not to damage these bars.

2. Removal of Bridge Deck Slabs

   a. The Contractor shall protect the public against injury and damage from demolition operations when removing portions of existing bridge deck slabs. When deck removal is performed over or near roadways, railroads or waterways, the Contractor shall furnish and erect temporary protective shields to prevent any material or debris from entering these areas.
   b. A minimum underclearance of fourteen and one-half feet (14-1/2′) shall be maintained over the roadway pavement and shoulders. No portion of the

shield including connection devices shall encroach on this underclearance. If less than sixteen feet (16′) underclearance is provided, the Contractor shall furnish and erect signs indicating the exact minimum underclearance. The signs and their location shall be approved by the Engineer. They shall be removed when the original underclearance is restored and shall become the property of the Contractor.

c. Working Drawings and design calculations for the protective shields shall be submitted for Engineer's review and approval. Flooring and siding shall have no cracks or openings through which material particles may pass. The shields shall be able to support over their entire area one-hundred fifty (150) lb/ft^2 in addition to their own dead weight.

d. The one-hundred fifty (150) lb/ft^2 in addition to its own dead weight requirement for protective shields will be waived when the span to be removed is not over any of the following, or within range of rolling debris reaching any of the following:

   1) Roadway, pedestrian walkway, bikeway, equestrian trail, parking area, navigable water, railroads and railroad property, or other traveled way.
   2) Exposed utilities that are either aerial utilities crossing under the span or utilities located between stringers.
   3) Environmental features such as historic ruins, endangered species habitat, etc.

e. When the one-hundred fifty (150) lb/ft^2 in addition to its own dead weight requirement is waived and the Contractor elects to remove the existing bridge deck slab by saw cutting sections and removing them by lifting from above, then the Contractor shall provide protection to prevent any loose particles from reaching the ground or waterway below. In addition, a temporary construction fence shall be placed under the area of demolition to prohibit accidental access by employees and possible pedestrians.

f. After the Engineer determines that the protective shields have served their purpose, they shall be removed and become the property of the Contractor.

3. Bridge Deck Slabs to be Replaced

a. On structures where the existing structural steel will be used in the finished structure and the Contractor elects to support the protective shields from the steel, all connections to the protective shields shall be made by means of clamps or other approved devices. The drilling of holes in the existing steelwork, or welding to the existing steel work for this purpose is prohibited.

b. Before removal operations begin, the outlines of the top flanges or cover plates of all stringers and floor beams shall be drawn on the bridge deck and one inch (1″) diameter pilot holes made outside these lines to confirm the location of the steel.

c. Prior to removing the existing slabs, the Contractor shall take elevations at locations along the bottom of the bottom flange or top of the top flange by removing small sections of slabs over stringers using pilot holes at the center and quarter points of all stringers and at other points if necessary, to provide a maximum spacing of twenty-five feet (25′) between elevations. After removing the deck, the Contractor shall take a new set of elevations

at the same points and ascertain the rebound. These rebounds shall be used in lieu of dead load deflections to establish grade controls and to produce finished tops of concrete bridge decks that will be true to as planned line and grade.

d. For bridge decks constructed with a longitudinal construction joint between stringers: diaphragms between these stringers shall not be disconnected unless specified in the Contract Documents.

e. On continuous bridges, the Contractor's proposed sequence of deck removal shall address uplift at the ends of continuous spans.

f. If damage results from the Contractor's operations, the removal operation shall be modified and the damaged items shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the City.

4. Removal and Salvage of Steel Members

a. When steel is to be salvaged for the City, it shall be removed with care to prevent damage. Before dismantling trusses, the Contractor shall match and mark all members, mark the size and length of both the beam and cover plate on top and bottom flanges and both sides of the web with white paint. No burning, cutting, or bending of the structural steel members will be permitted.

b. All diaphragms and connector plates attached to existing beams shall be carefully removed. Riveted and bolted joints may be disconnected by cutting the rivet or bolt heads. Removal of welds from existing beams, diaphragms and connector plates shall be by the air arc method.

c. Salvaged materials shall be loaded, hauled, unloaded and stacked at a site specified in the Contract Documents or as directed by the Engineer. The Contractor shall notify the Engineer a minimum of forty-eight (48) hours prior to delivery of salvaged materials.

d. The Contractor shall arrange for provisions to store the material off the ground and for unloading and neatly packing of the material at the City's designated storage site. The material shall be stored off the ground and protected as far as practicable from surface deterioration by exposure to conditions producing rust. These materials shall be kept free of dirt accumulation, oil or other deleterious matter.

5. Removal of existing bridge including piles, shall be removed to an elevation of at least one foot (1′) below subgrade or existing ground, unless otherwise specified in the Contract Documents or as directed by the Engineer. Blasting will not be permitted without the written approval of the Engineer. Piles, grillage, or cribbing under removed bridge shall be cut off and removed to at least one foot (1′) below subgrade or existing ground, unless otherwise specified in the Contract Documents or as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The removal of existing bridges and structures or portions thereof will be measured and paid for as specified. The payment will be full compensation for all excavation, backfill, saw cuts, professional Engineer services, temporary protective shields, temporary sheeting and shoring, hauling, disposal, and for all material, labor, equipment, tools, and

sheeting and shoring, hauling, disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Construction fence used to restrict access under demolition areas will not be measured but the cost will be incidental to the pertinent removal of existing structure item. When an item for construction fence is included in the Contract Documents, that portion of the construction fence used to protect demolition areas will not be included in the measurement and payment for that item.

C. The removal of existing structures will not be measured for payment but will be paid for at the pertinent Contract lump sum price.

D. The removal of existing concrete parapets on bridges and wing walls, concrete median barriers on bridges and barrier portion of retaining walls will not be measured but will be paid for at the Contract lump sum price for the pertinent removal of existing concrete parapet or removal of existing concrete barriers from structure items. The payment will be full compensation for all temporary protective shields, hauling, disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

E. Removal of existing structures for which no specific pay item is included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

F. When the item removal of existing bridge is specified in the Contract Documents, the item will not be measured for payment but will be paid for at the Contract lump sum price. The payment will be full compensation for the removal of the structure, substructure, piles, supports, cribbing, grillage, salvage or disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

DIVISION 03
CONCRETE
03 01 00 MAINTENANCE OF CAST-IN-PLACE CONCRETE

03 01 30.41 MAINTAINING EXISTING BRIDGE DECK DURING LIFE OF CONTRACT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of patching the existing bridge deck as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Rapid Hardening Cementitious Material for Concrete Pavement Repairs shall conform to the following:

1. Materials shall be a dry, packaged cementitious mortar having less than five percent (5%) by weight of aggregate retained on the three-eighths inch (3/8") sieve and shall conform to the following requirements:

a. Classification.

1) Class I For use at ambient temperatures below fifty degrees (50°) F.
2) Class II For use at ambient temperatures of fifty to ninety degrees (50° to 90°) F.
3) Class III For use at ambient temperatures above ninety degrees (90°) F.

b. Chemical Requirements: The material shall conform to the chemical requirements of C 928 and contain no organic compounds such as epoxy resins or polyesters as the principal binder.

c. Physical Requirements: The material shall conform to the following when tested as specified in Maryland standard Methods of Testing (MSMT) 725:

COMPRESSIVE STRENGTH, psi minimum				
	< 2 hr	2-6 hr	6 hr	28 days
Type I — Slow	—	—	2000	4500
Type II — Rapid	—	2000	—	4500
Type III — Very Rapid	2500	—	—	4500

TEST RESULTS	
Bond Strength, 7 days, psi minimum	2000
Length Change, increase after 28 days in water, based on length at 3 hr, % max	+ 0.15
Length Change, decrease after 28 days, % max	- 0.15
Freeze Thaw, loss after 25 cycles in 10% $CaCl_2$ solution, % max	8
Initial Setting Time, minutes minimum	10

d. Marking: All packages delivered to the project shall be marked with the following information:

1) Date material was packaged.
2) Approximate setting time.
3) Recommended dosage of water or liquid component.
4) Mixing instructions.
5) Class or temperature range.

e. Certification: The manufacturer shall furnish certification as specified in TC-1.02 showing the actual test results for each class and type of material submitted to the Laboratory.

f. The Contractor shall select the patching material from the prequalified list of rapid hardening cementitious materials maintained by the Office of Materials and Technology.

PART 3 EXECUTION

A. The Engineer and Contractor shall periodically review the existing deck and determine if any patching is necessary. All holes over one inch (1″) deep having an area greater than two foot square (2 ft^2) shall be patched. Locations and limits of all patch areas shall be approved by the Engineer.

B. Before patching begins, the Contractor's Traffic Manager shall confer with the Engineer to decide on a plan for diverting or detouring traffic during patching operations. All items relating to traffic safety and traffic control requirements shall conform to the Contract Documents.

C. The areas requiring patches shall be clean and free of loose material and conform to the manufacturer's recommendations.

D. When working on a full depth patch area, the Contractor shall protect waterways and roadways under the structure from falling debris. No removed material shall be disposed of in any waterway.

E. The patching material shall be placed full depth to the top of the existing bridge deck surfaces.

F. New reinforcement will only be required when directed by the Engineer.

G. When a patch has been made and it has not yet reached sufficient strength to support traffic when this section of the structure is opened to traffic, it shall be covered with a steel plate as specified in the following requirement. All areas around the plate shall be built up with asphalt material.

1. Steel Plates. The Contractor shall have an ample supply of twelve foot by fourteen foot by one inch (12′ X 14′ X 1″) thick steel plates available on the project to cover emergency filler or be placed over the patch area until the concrete has developed sufficient strength to carry traffic.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Patching for Maintaining Existing Bridge Deck will be measured and paid for at the Contract Unit Price per square foot. The payment will also be full compensation for the removal of material required to prepare the patch area, including chipping and hand cleaning, as well as furnishing and placing reinforcement steel, forming, providing protective structures, and furnishing, placing and removing any steel plates. Patches performed day or night will be paid for at the Contract Unit Price.

C. All Work, materials, sequence of operations and cones required to maintain traffic during each occurrence of patching, including removal after patching is complete, will be measured and paid for at the Contract Unit Price per each item. When more than one (1) patch is made under one movement of traffic for patching, the item will be paid for only once, regardless of the number of patches made or the length of time traffic is rerouted. When traffic must be maintained more than once for a particular patching operation, the Work will be measured and paid for only once.

D. Floodlighting. Floodlighting will not be paid for unless approved by the Engineer in writing. When floodlighting is approved, it will be paid for as specified in the following:

1. Floodlighting will be measured and paid for at the Contract Unit Price per each night used, including fuel, backup generator, set up, relocation, and removal.

03 15 00 CONCRETE ACCESSORIES

03 15 13 DAMP PROOFING AND WATER STOPS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of damp proofing and waterproofing of concrete surfaces.

PART 2 PRODUCTS

1.2 MATERIALS

A. Asphaltic Materials:

1. Hot Applied Asphalt. Hot applied asphalt shall conform to D 449.
2. Cold Applied Asphalt. Cold applied asphalt shall conform to the following when tested as specified in Maryland Standard Methods of Tests (MSMT) 423, Procedure A. The material shall not contain isocyanide or any derivative of cyanide.

TEST AND METHOD		SPECIFICATION LIMITS		
		GRADE I	GRADE II	GRADE III
R & B Softening Point T 53		104° – 143° F	145° – 170° F	172° – 200° F
Penetration, 0.10 mm T 49	32° F, 200 g, 60 sec	10 min	5 min	5 min
	77° F, 100 g, 5 sec	30 – 100	25 – 50	20 – 40
	115° F, 50 g, 5 sec	100 min	130 max	100 max
Permeability, g/cm^3, max, MSMT 423		0.09	0.09	0.09
Flow test, mm, max, MSMT 423		CC	20	15
Flexibility, 60° F, MSMT 423		No peeling or loss of adhesion		
Imperviousness Test, MSMT 423		No pitting or discoloration		
Sag test, MSMT 423		No movement		

Grade I Suitable for below ground and horizontal applications.
Grade II Suitable for below ground and above ground where surface temperatures do not exceed one-hundred twenty degrees (120°) F.
Grade III Suitable for below ground and above ground where surface temperatures exceed one-hundred twenty degrees (120°) F.

3. Cold Applied Asphalt Emulsion. Cold applied asphalt emulsion shall conform to D 1227, Type II, when tested as specified in D 2939, modified by MSMT 423, Procedure B.

B. Asphalt Primer: The primer shall conform to D 41.

C. Fabric for Use with Asphalt: The fabric shall conform to D 173.

D. Membrane Waterproofing and Damp Proofing: The adhesive side of the membrane shall be protected with a special release paper that can be easily removed for installation. The membrane shall conform to the following requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Grab Tensile Strength, lb/inch @ 12 inches/minute rate of loading, min	D 5034	70
Pliability, 180° bend, 1 inch mandrel @ 20° F	D 146	unaffected
Resistance to Puncture, lb min	E 154 (square mounting frame method)	40
Permeance, perm (kg/Pa · s · m^2), max	E 96, Method B	0.1
Weight, oz/yd^2 min	D 3776	40
Primer	—	As specified by mfgr.

E. Roll and sheet waterproofing membrane may be accepted on certification. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/ vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

PART 3 EXECUTION

3.1 GENERAL

Damp proofing and waterproofing shall be applied using asphaltic materials, primers and fabric, or by the roll or sheet method. An alternate system of waterproofing or damp proofing consisting of rolls or sheets of membrane material may be used in lieu of the above coatings. The rolls or sheets shall be applied in conformance with the manufacturer's recommendations.

3.2 STORAGE

Waterproofing fabrics and membranes shall be stored in a dry protected place. Asphalt materials in containers shall be kept closed when not in use.

3.3 SURFACE PREPARATION

A. Damp proofing or membrane waterproofing shall not be applied until curing has been completed and surfaces are protected against cold. All surfaces shall be dry, smooth, and free from projections and holes.

B. When damp proofing and membrane waterproofing are both specified for application, the membrane waterproofing shall be applied first. Damp proofing or membrane waterproofing shall not be permitted when the temperature is less than forty degrees (40°) F.

3.4 DAMP PROOFING

A. When asphaltic coatings are used for damp proofing, they shall consist of two (2) prime coats and one (1) seal coat. Damp proofing shall be applied to the following concrete surfaces that will be in contact with backfill:

1. Rear face of abutments and abutment wing wall stems.
2. Rear faces of headwalls and wing walls for pipes thirty-six inches (36″) in diameter or larger and for culverts.
3. Rear face of retaining wall stems.
4. The following areas pertain to reinforced concrete box culverts:

    a. Top of top slabs when not built to grade.
    b. Entire outside surfaces of side walls.
    c. Additionally, bottom of bottom slabs of precast units.

3.5 WATERPROOFING

A. When asphaltic coatings are used for waterproofing, they shall consist of a prime coat, three (3) mop coats, and two (2) layers of fabric.

B. Waterproofing shall be applied to all construction joints of a concrete structure that are next to backfill above normal water surface with backfill on one side and atmosphere on the other side. It shall be applied with a minimum width of sixteen inches (16″) centered on the joint.

3.6 APPLICATION OF DAMP PROOFING

A. Care shall be taken to confine all coatings to the areas to be covered to prevent coating of parts of the structure that will be exposed to view in the completed structure. Damp proofing shall be applied to the full face of all contraction joints.

B. The damp proofing material shall be applied in conformance with the manufacturer's recommendations. When no recommendations are provided, the damp proofing material shall be applied to the cured, cleaned, and dry surfaces as follows:

1. Paint with two (2) coats of primer for absorptive treatment at a rate of one-eighth (1/8) gal/yd^2 per coat. The second coat shall not be applied until the first coat has thoroughly dried. The material shall not be heated.
2. After the second prime coat has thoroughly dried, one (1) seal coat shall be applied by brush or roller at a rate of one-eighth (1/8) gal/yd^2. When necessary, this material may be heated, but not in excess of one-hundred fifty degrees (150°)F.

3.7 APPLICATION OF MEMBRANE WATERPROOFING

A. When membrane waterproofing is applied, the cured, cleaned and dry surfaces shall be coated with a prime coat and covered with mop coats and layers of fabric.

B. Coating Procedure:

1. The surfaces shall first be coated with a primer at a rate of one-eighth (1/8) gal/yd^2. The prime coat shall be applied twenty-four (24) hours in advance of applying any mop coats and shall be dry before the first mopping is applied. The primer shall not be heated.
2. Asphalt for mop coats shall be heated to a temperature between three hundred and three-hundred fifty degrees (300° and 350°) F, with frequent stirring to avoid local overheating. The heating kettles shall be equipped with thermometers.
3. The waterproofing shall begin at the low point of the surface to be waterproofed, so that water will run over and not against or along the laps.
4. The first strip of fabric shall be half width. The second shall be full width, lapped the full width of the first sheet. The third and each succeeding strip thereafter shall be full width and lapped so that there will be two (2) layers of fabric at all points and three (3) layers with laps not less than two inches (2″) wide at edges of strips. All laps at ends of strips shall be twelve inches (12″) wide.
5. Beginning at the low point of the surface to be waterproofed, a section twenty inches (20″) wide and the full length of the surface shall be mopped with the hot asphalt. Immediately following the mopping, the first strip of fabric shall be pressed into place eliminating all air bubbles. This strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used shall then be mopped with hot asphalt and a full strip and a full width of the fabric shall be pressed into place as before. The forward or upgrade half of this second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip not less than two inches (2″). This process shall be continued until the entire surface is covered. The entire surface shall then be given a final mopping of hot asphalt. There shall be a complete coating of asphalt between all layers of fabric.

6. In all cases, the mopping on concrete shall cover the surface so that no gray spots appear, and on the cloth it shall be sufficiently heavy to completely conceal the weave. Asphalt shall be applied at the rates of one point two (1.2) gal/yd^2 on horizontal surfaces and one point four (1.4) gal/yd^2 on vertical surfaces. The Work shall be regulated so that at the close of a day's work, all cloth that was laid shall have received as many coatings as was required for that stage of completion. Special care shall be taken at all laps to see that the cloth is thoroughly sealed down.

3.8 ROLL OR SHEET WATERPROOFING MEMBRANE

An alternate system of waterproofing or damp proofing consisting of rolls or sheets of membrane material may be used in lieu of the above coatings. The rolls or sheets shall be applied in conformance with the manufacturer's recommendations.

3.9 MEMBRANE CARE

At the edges of the membrane and any points where it is punctured by appurtenances such as drains or pipes, it shall be flashed in a manner acceptable to the Engineer to prevent water from getting between the waterproofing and the waterproofed surface. Damage to the membrane shall be repaired. Repairs shall extend beyond the outermost damaged portion, and the second ply shall extend at least three inches (3″) beyond the first.

PART 4 MEASUREMENT AND PAYMENT

Damp proofing and membrane waterproofing will not be measured but the cost will be incidental to other pertinent items specified in the Contract Document.

03 15 14.01 EXPANSION JOINTS IN STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, fabricating, and installing preformed joint fillers, preformed elastomeric joint seals, troughs, structural steel and metal plates to be utilized in providing expansion and contraction capabilities in structures as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hardware for Drainage Troughs; Bolts, Nuts and Washers for general use: Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.

B. Preformed Joint Fillers: Preformed joint fillers shall conform to M 153. The bituminous fiber type shall conform to M 213, with the bitumen content determined using T 164. The weathering test shall be deleted for either type of material.

C. Preformed Polychloroprene Elastomeric Compression Joint Seals:

1. The manufacturer shall furnish certification as specified in TC-1.02.
2. Roadway seals for concrete pavement shall conform to M 220.
3. Bridge seals shall conform to M 297. The minimum depth of all seals measured at the contact surface shall be at least ninety percent (90%) of the minimum uncompressed width of the seal.

D. Lubricant Adhesive: The lubricant adhesive shall be compatible with the preformed joint seals and concrete. The Engineer will determine if consistency is suitable at the time of installation. The manufacturer shall furnish certification showing that the lubricant adhesive conforms to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, D 1084, Method B, CP min	25000
Film Strength, D 412, psi min	2000
Elongation, D 412, % min	250

E. No lubricant adhesive shall be used after nine (9) months from the date of manufacture. Each container shall be plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture.

F. The manufacturer's certificate shall verify that the material and Work complies with the Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

G. Troughs: Neoprene for drainage troughs shall conform to M 220 and the following:

PHYSICAL PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Tensile Strength, psi min	D 412	2000
Elongation at Break, % min	D 412	250
Hardness, Type A Durometer	D 2240 (modified)	60 ± 5
Compression Set, 22 hr @ 212° F, % max	D 395	35
Oven Aging, 70 hr @ 212° F		
Tensile Strength, % loss max	D 573	20
Elongation, % loss max		20
Hardness, Type A Durometer (points change)		0 to +10

H. Structural Steel shall conform to A 709, Grade 36. All structural steel for drainage troughs shall be hot-dipped galvanized as specified in A 123. Troughs shall be one-quarter inch (1/4") thick. Joints or splices for drainage troughs are prohibited except as indicated on the Contract Documents.

2.2 PAINT

A. The color of the finish coat shall conform to federal standards. The Contractor may substitute two (2) coats of epoxy protective coating in lieu of Coats II and III of any of the following paint systems:

1. New Expansion Joints. Paint shall conform to the Paint System Table, System B.
2. Existing Expansion Joints and New Portions. Paint shall conform to the Paint System Table, System E. The Contractor may substitute Coat I of System A in lieu of Coat I of System E for new portions of expansion joint widening.

PAINT	COAT	SECTION	DRY FILM THICKNESS, Mils, Min/Max	USAGE
SYSTEM A				
Inorganic Zinc	I	912.02.01	3.0 - 5.0	Shop Primer
Acrylic	II	912.03.01	2.0 - 4.0	First Field Coat
Acrylic	III	912.04.01	2.0 - 4.0	Finish Coat
SYSTEM B				
Inorganic Zinc	I	912.02.01	3.0 - 5.0	Shop Primer
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	First Field Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat
SYSTEM E				
Aluminum Epoxy Mastic	I	912.02.02	5.0 - 8.0	Primer/First Cover-All Coat
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	Second Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat

B. The two (2) coats of epoxy protective coating shall be two (2) component epoxy systems for use in conjunction with concrete. One (1) component shall be a clear or pigmented condensation product of the reaction of epichlorohydrin with bisphenol A, the resin of which shall be composed of one hundred percent (100%) reactive constituents. The other component shall be a clear polyamide hardener.

C. The producer shall submit a sample of each component for laboratory analysis. The sample shall be coded as the original sample. The original and all subsequent samples shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Pot Life, hr min	Fed. Spec TT-C-535	8
Color	Fed. Standard 595	Gray No. 26440
Dry Film Thickness	D 1005	2
Sagging	D 4400	Must pass test for Recommended
Flexibility	Federal Spec TT-P-115	Must not crack, check or delaminate
Infrared Spectrogram	Equipment	Each component shall match
Tensile Strength, psi min	MSMT 609	400

PART 3 EXECUTION

3.1 GENERAL

A. Expansion joint material delivered to the bridge site shall be stored under cover on platforms above the surface of the ground. It shall be protected at all times from damage and when placed it shall be free from dirt, oil, grease, or other foreign substances. All welding shall conform to AWS D1.1 unless otherwise specified in the Contract Documents. The Contractor shall have all material and installation methods approved by the Engineer prior to installation of any expansion joint material.

B. The preformed material shall consist of the longest length possible with a minimum of joints. Lengths less than four feet (4') shall be one (1) piece. The material shall be cut to a clean, true edge with a sharp tool. Care shall be taken to ensure straight lines at the joint.

C. When installing the seal, the Contractor shall not use any type of equipment that will damage the seal. If the seal is damaged during installation, the Contractor shall remove and replace the seal at no additional cost to the City.

3.2 NEW EXPANSION JOINTS

A. Prior to any shop painting operations, all surfaces of the expansion dam and backwall angles shall be cleaned in the shop. All oil, grease, and other substances shall be removed from steel surfaces prior to blast cleaning. The Contractor shall use approved method and materials such as solvents, emulsions, cleaning compounds, steam cleaning, or similar in conformance with SSPC-SP 1. Soap steam cleaning shall be used in cleaning steel open grid decks and walkways and machinery areas of drawbridges.

B. Contaminated solvent shall be removed before it evaporates by wiping or rinsing with clean solvents to prevent a film of contaminants from remaining on the surface. Solvent wiping may be required between coats.

C. All solvents shall be approved in writing by the paint manufacturer.

D. After all shop fabrication is complete, blast clean all surfaces of nonweathering steel. Sufficient amounts of steel grit mixed with cast iron, malleable iron, steel, or synthetic shot propelled through nozzles or centrifugal wheels conforming to SSPC-SP 10. The end surface condition shall produce an etched surface texture as opposed to the peened surface texture typical of shot blasting and shall conform to near white. Shot blast cleaning is prohibited in the field.

E. The prime coat shall be applied in the shop to the entire area of the backwall and expansion dam angles including those areas in contact with concrete, except the portion which is masked to receive adhesive for the seal.

3.3 EXISTING EXPANSION JOINTS

A. Prior to any painting operations on existing expansion joints and new steel used to modify them, all surfaces of the expansion dam angles and backwall angles to be painted or receive adhesive for the seal shall be thoroughly blast cleaned to conform to a near white condition using either abrasive blast cleaning or shot blast cleaning procedures as described herein.

1. Abrasive Blast Cleaning. Steel grit propelled through nozzles or centrifugal wheels conforming to SSPC-SP 10 shall be utilized unless otherwise approved by the Engineer. The end surface condition shall conform to near white. Abrasives shall be dry and free of oils, grease, and other harmful materials such as lead dust etc., at the time of use. Cleanliness of the steel grit shall be verified prior to start of Work in conformance with SSPC AB-3 and at least one (1), eight (8) hour shift every month thereafter in conformance with SSPC AB-2.
2. Shot Blast Cleaning. Sufficient amounts of steel grit mixed with cast iron, malleable iron, steel, or synthetic shot propelled through nozzles or centrifugal wheels conforming to SSPC-SP 10. The end surface condition shall produce an etched surface texture as opposed to the peened surface texture typical of shot blasting, and shall conform to near white. Shot blast cleaning is prohibited in the field.

B. The area that will be in contact with the seal shall then be completely masked for full length and depth of seal.

C. The backwall and expansion dam angles shall have all prime coats applied to the entire area that will be exposed in the finished structure, both above and below the seal. These coatings shall be applied in the shop for new steel members.

D. Where the Contract Documents specify replacement or modification to existing expansion joints on bridges on which traffic will be maintained, the Contractor shall have available a supply of steel plates having minimum dimensions of four foot by eight foot by one inch (4′ X 8′ X 1″) thick. These plates shall be placed over the joints if traffic has to be restored before the concrete has cured or at any time the unfinished Work will interfere with traffic.

E. Where the Contract Documents specify modification to existing expansion joints, the concrete shall be removed in conformance with 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements).

F. Where the Contract Documents only specify replacement of existing roadway joint seal, the Work shall include cleaning and painting the joint.

G. All angles shall be cut with a saw. All holes and slots shall be drilled. Cutting with a torch is prohibited.

H. Any areas where the existing steel coating is damaged due to the installation of new troughs shall be power tool cleaned to bare metal and painted.

3.4 PAINT

A. If this is the only portion of bridge to be painted, the paint need not be tested by the Laboratory if, prior to use, a copy of the certified test results has been furnished to the Engineer specifying that the paint conforms to 09 97 13.24, (Exterior Steel Coatings Cleaning and Painting Existing Structural Steel).

B. The primer shall be applied on the same day that the blast cleaning takes place. The primer shall be sprayed in a single application with dry film thickness of three to five (3 to 5) mil. All touch-ups may be applied by brush and shall have the same dry film thickness as the coat being repaired.

C. After the joints are in place and just prior to placing the compression seal, the masking tape shall be removed and the seal installed. The finish coat shall then be applied to the exposed portion of the angles above the seal.

3.5 JOINT SEALS IN BRIDGE DECKS

A. The transverse compression seals shall be one (1) piece for the entire length of the roadway joint. Shop or field splices in the seal are prohibited. Compression seals for longitudinal bridge joints shall consist of the longest piece practical.

B. Lubricant adhesives shall be applied in conformance with the manufacturer's recommendations. If stretching of the seal in excess of five percent (5%) occurs, the Contractor shall remove and reinstall the seal as directed by the Engineer.

3.6 IN-PLACE TESTING

A. The completed joint shall be subjected to a water test to detect any leakage. The test shall be conducted a minimum of five (5) days after completion of the joint. The Contractor shall provide all facilities required for the Engineer's inspections of the under deck areas at no additional cost to the City. The roadway section of the joint from curb to curb, or parapet to parapet, shall be covered with a minimum of one inch (1″) of water. If this is not possible, the water test may be performed in partial sections along the joint. When testing subsequent partial sections, the test shall overlap a minimum of one foot (1′) of the joint previously tested.

B. The ponding shall be maintained for a period of five (5) hours for the entire roadway or each section of joint being tested. During and at the conclusion of the test, the underside of the joint shall be closely examined for leakage. The expansion joint seal shall be considered watertight if no obvious wetness is visible.

C. If the joint system exhibits evidence of water leakage at any point, the Contractor shall locate and repair all leaks at no additional cost to the City.

D. When repairs are required, a subsequent water test shall be performed.

E. If the joint leaks after the second test, the Contractor shall remove, replace and retest the seal at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for furnishing, fabricating, placing, etc., of structural steel, roadway seals, drainage troughs, catch basins, downspouts, cleaning, painting, and all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. Joints in structures will not be measured but the cost will be incidental to the pertinent Superstructure concrete item.

C. When an item for modifying existing bridge roadway joints is included in the Contract Documents, the cost of furnishing, fabricating, placing, etc., of new structural steel, new roadway seals, modifying existing joints on bridge roadway including saw cutting and removal of existing concrete, new concrete, steel plates, cutting of existing steel, welding, drainage troughs, catch basins, downspouts, etc., shall also be included in the Contract Unit Price per linear foot for the item. The measurement will include the horizontal distance from the inside face to inside face of parapets plus the vertical distance of the curb faces and parapets.

D. When an item for drainage trough for bridge is included in the Contract Documents, the furnishing and placing of drainage troughs including catch basins, downspouts, structural steel and hardware will be measured and paid for at the pertinent Contract Unit Price per linear foot. This price will include cutting of angles, painting, drilling of concrete, expansion bolts, etc. The measurement will be the centerline distance from end to end of the installed drainage trough fabric.

03 15 15 BEARING AND EXPANSION PADS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing bearings of the type and size specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Plates: Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

B. Bronze or Copper Alloy Bearing and Expansion Plates: Bronze or copper alloy plates shall be either of cast bronze or rolled copper alloy.

1. Cast Bronze. Cast bronze bearing and expansion plates shall conform to B 22, Alloy No. 91100 or No. 91300.

a. Self-lubricating bronze bearing plates shall be an article of standard production by an approved manufacturer of such equipment. They shall be provided with trepanned recesses (not grooves) that shall be filled with a lubricating compound consisting of graphite and metallic substances with a

lubricating binder capable of withstanding the atmospheric elements. The lubrication compound shall be compressed into the recesses by pressure to form dense, nonplastic, lubricating inserts. The lubricating area shall comprise not less than twenty-five percent (25%) of the total area. The static coefficient of friction shall not exceed 0.10.

b. The certification shall be as specified above and shall include the actual test results showing that bearing plates of the same design as those supplied conform to the static coefficient of friction requirements.

c. Test specimens shall measure not less than four inches long by four inches (4″ X 4″) wide. The static coefficient of friction shall be determined by testing a specimen plate subjected to a vertical pressure of one thousand (1000) psi and one thousand (1000) cycles consisting of one-half inch (1/2″) horizontal strokes at a speed not to exceed nine (9) cycles per minute. Testing shall be conducted at an ambient temperature of seventy-seven degrees (77°) plus or minus nine degrees (± 9°) F. The static coefficient of friction on the specimen bearing plate shall be calculated by dividing the total applied vertical load on the plate into the total horizontal load required to start motion between the bearing plate and its mating surface while subject to the vertical load. Upon completion of the test, the bronze plate shall show no signs of galling.

2. Rolled Copper: Rolled copper alloy bearing and expansion plates shall conform to B 100, Alloy No. 51000.

C. Elastomeric Bearing Pads: The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

D. Certifications for metal products shall include a statement that the material was melted and manufactured in the United States except as provided in the federal guidelines with regard to the furnishing and coating of iron and steel products. A nationwide waiver for this provision has been granted for pig iron and processed, pelletized, and reduced iron ore.

1. Elastomeric bearing pads shall conform to the material requirements described in the AASHTO Standard Specifications for Highway Bridges. The elastomeric bearing shall be sixth (60) durometer hardness, Shore Type A. Accompanying the certificate for elastomeric bearing pads shall be two (2) standard ASTM tensile slabs molded from the same compound batch as the furnished elastomeric bearings.
2. The static load deflection of any layer of elastomeric bearing pads shall not exceed seven percent (7%) at eight hundred (800) psi average unit pressure when tested under laboratory conditions.
3. The design load for the elastomeric bearing pads will be specified in the Contract Documents. The manufacturer shall proof load each steel reinforced bearing design with a compressive load of one and one-half (1-1/2) times the maximum design load and shall specify that the material conform to the material certification.
4. When test specimens are cut from an actual bearing pad, a reduction of ten percent (10%) in the minimum requirements for original tensile strength and ultimate elongation will be required.

E. Preformed Fabric Pads: Preformed fabric pads shall be composed of multiple layers of eight (8) oz cotton duck impregnated and bound with high quality natural rubber or of equally suitable materials, approved by the Engineer and compressed into resilient pads of uniform thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than ten thousand (10,000) psi without detrimental reduction in thickness or extrusion.

F. Epoxy Adhesives:

1. Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and contain no volatile solvents, lumps, or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging.
2. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification or data sheet shall show actual test results for each required property of the type, grade, and class of epoxy submitted, and shall accompany each sample.
3. The manufacturer shall supply actual bond test results for each batch submitted for use.

PART 3 EXECUTION

3.1 STORAGE AND HANDLING

Bearings shall be stored under cover on a platform above the ground surface. They shall be protected from damage at all times and, when placed, shall be dry, clean, and free of dirt, oil, grease, or other foreign substances.

3.2 INSTALLATION

A. Masonry bearing plates shall be erected on surfaces finished to the elevations shown on the Contract Documents. The Contractor shall check the elevation of each bearing area prior to finishing to insure conformance. Each area shall be checked for level in all directions using a spirit level and adjustments made prior to the setting of the concrete. The area shall be steel troweled to a dense flat surface. Bearing areas that are not flat after final finishing shall be ground to achieve an acceptable surface. Bearing areas will be rejected whenever the elevation is below that of the surrounding masonry.

B. The masonry bearing plates shall be placed on a single thickness of preformed fabric bearing pad.

C. The bearings and pedestals of truss, beam and girder spans, and the center and end bearing of swing spans shall be rigidly and permanently located to correct alignments and elevations.

D. The attachment of bearings or plates to steel superstructures shall conform to the applicable portions of 05 12 00, (Structural Steel Framing) Specifications.

3.3 STEEL, BRONZE, OR COPPER BEARINGS

When steel, bronze, or copper alloy bearings are specified in the Contract Documents, the machined bearing surfaces shall be thoroughly cleaned immediately before erection. As soon as practical after erection, all unpainted exposed surfaces of the bearings scheduled for painting, shall be given one (1) prime coat before application of the specified field coats.

3.4 ELASTOMERIC BEARING PADS

A. When elastomeric bearing pads are specified in the Contract Documents, the pads delivered to the bridge sites shall be stored under cover on platforms a minimum of four inches (4″) above the surface or vegetation. Pads shall be kept dry and protected from damage and contamination from foreign substances at all times.

B. Prior to installation, the pads and abutting surfaces shall be given a final cleaning to assure that they are free of all dust, dirt, oil, grease, moisture, or other foreign substances. Cleaning shall be done with an approved solvent that is compatible with the adhesive prior to application of the epoxy adhesive. The epoxy adhesive shall be mixed and applied in conformance with the manufacturer's recommendations.

C. When the elastomeric pads are used without masonry bearing plates, the masonry bearing surfaces shall be ground to remove all laitance before the application of the adhesive. The surfaces of the masonry bearing areas that will be in contact with the bearing pads and the full contact area of the bearing pad shall be coated with the epoxy adhesive. After the adhesive is applied and the pads are set in place, blocking or other approved mechanical methods shall be used to secure the pads in their final position until the adhesive has set up.

D. Surface temperatures and predicted ambient air temperature for the next four (4) hours shall be fifty degrees (50°) F or higher at the time of application unless otherwise specified in the Contract Documents or recommended by the epoxy adhesive manufacturer and approved by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

Bearings will not be measured but the cost will be incidental to other pertinent items specified in the Contract Document.

03 15 16 APPLICATION OF BRIDGE/STRUCTURE NUMBERS

PART 1 GENERAL

This Work shall consist of applying Bridge/Structure Numbers to completed structures.

PART 2 PRODUCTS

2.1 MATERIALS

The paint shall be suitable for the particular application and shall be selected by the Contractor subject to the approval of the Engineer.

PART 3 EXECUTION

A. The Bridge/Structure Number shall be applied to the bridge/structure as a last order of Work. The size, location, etc., shall conform to the pertinent details included in the Contract Documents. All Work shall be done in a neat workmanlike manner with sharp edges differentiating between all coatings and the previous substrate. Surfaces shall be properly prepared in conformance with the paint manufacturer's recommendations. Paint shall not be applied to wet or moist surfaces.

B. On rehabilitation projects the Bridge/Structure Number shall be repainted if it is faded, removed, or otherwise deemed necessary by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

Application of Bridge/Structure Numbers will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

03 20 00 CONCRETE REINFORCING

03 21 00 REINFORCING STEEL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and placing reinforcement, including deformed steel bars, wire mesh, and plain round steel spiral bars, as specified in the Contract Documents or as directed by the Engineer. Reinforcement shall be uncoated or epoxy coated as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Grout: Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of five thousand (5000) psi in seven (7) days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of zero percent (0.0%) after seven (7) days when tested as specified in T 160.

B. Deformed Steel Bars: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to the following:

1. The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in

the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the prequalified materials list from the Engineer.

2. Epoxy coatings shall conform to D 3963.
3. Material used for the touch up system shall be a two (2) part epoxy system designated and color matched for patching the epoxy coating used.
4. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.
5. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.
6. Certifications for metal products shall include a statement that the material was melted and manufactured in the United States except as provided in the federal guidelines with regard to the furnishing and coating of iron and steel products. A nationwide waiver for this provision has been granted for pig iron and processed, pelletized, and reduced iron ore.

C. Plain Round Steel Bars for Column Spirals: Unless otherwise specified, dowel bars and dowel bars used as ties in portland cement concrete pavement expansion and contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated. Epoxy powder shall conform to section 2.1 B 1.

D. Wire Mesh:

1. Welded steel wire fabric shall conform to M 55. Fabric used in pavement construction shall be furnished in flat sheets.
2. Welded deformed steel wire fabric shall conform to M 221.

E. Fusion Bonded Epoxy Powder Coating for Steel and Touch Up System:

1. Epoxy Powder Coating: The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the prequalified materials from the Engineer.
2. Epoxy coatings shall conform to D 3963.
3. Touch Up System: Material used for the touch up system shall be a two (2)-part epoxy system designated and color matched for patching the epoxy coating used.
4. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.

5. Certification: The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

F. Galvanizing shall conform to A 153.

2.2 SUPPORTS

A. Material for all supports shall be approved coated metal, plastic, plastic tipped, or galvanized. Aluminum is prohibited. All materials shall be acceptable to the Engineer.

B. The wire supports for epoxy coated steel bars shall be completely covered with one and one-half to nine (1.5 to 9.0) mil of adherent epoxy coating except for minimum necessary contact marks. The reinforcement steel shall be held in place with plastic coated tie wires fabricated for this purpose.

C. Steel bars used as supports for epoxy coated steel bars shall be epoxy coated in the same manner as reinforcement steel.

PART 3 EXECUTION

3.1 WORKING DRAWINGS

A. The Contractor shall submit Working Drawings to be approved by the Engineer prior to the start of any fabrication unless otherwise specified.

B. The Plans will be supplemented by Working Drawings as necessary to adequately control the Work. All authorized alterations affecting the requirements and information given on the Working Drawings shall be in writing to the Engineer. When reference is made to the Working Drawings, the interpretation shall be the Working Drawings as affected by all authorized alterations then in effect.

C. Working Drawings will show details of all structures, lines, grades, typical cross section of roadway, general cross sections, location and designation of all units and elements. The Contractor shall provide, at no additional cost to the City, all required Working Drawings and shall have them adequately checked, after which they shall be submitted to the Engineer for review. The Engineer may reject Working Drawings and return them for revisions, in which case the Contractor shall submit revised Working Drawings as required. No items involving the Drawings shall be incorporated into the Work until the drawings have been accepted for use by the Engineer; however, acceptance shall not relieve the Contractor of any responsibility in connection with them. All Working Drawings shall be furnished in duplicate for preliminary examination for projects prepared by the City and in triplicate for projects prepared by consultant engineering firms for the City. After Working Drawings have been accepted for use by the Engineer, the Contractor shall furnish additional copies as requested.

D. All Working Drawings shall be on sheets measuring twenty-two inches by thirty-six inches (22″ X 36″) and shall have a standard title block at the lower right corner approximately four inches by eight inches (4″ X 8″) and two inches (2″) for the revision column on the left

side and the remaining six inches (6″) for the title; indicating the following information in the order named:

Name of Contractor (and Subcontractor, if applicable)
Address of Contractor (and Subcontractor, if applicable)
Sheet Title (Reinforcement Details, etc.)
Name of Structure
Crossing
For (City of Baltimore)
By (Indicate name of Contractor's official or engineer, or other parties authorized to sign official documents.)

E. Approval of Foundations. The Contractor is cautioned against the risk involved in having reinforcing steel fabricated before approval of foundations.

3.2 PLAN DIMENSIONS

All dimensions related to reinforcement steel are out to out measurement, except the spacing is measured center to center.

3.3 CUTTING AND BENDING

A. Reinforcement bars shall be cut and bent at the mill or shop to the shapes specified in the Contract Documents before shipment to the job site. Reinforcement bars shall not be bent in the field except to correct errors, damage by handling and shipping, or minor omissions in shop bending.

B. Epoxy coated reinforcement bars on skewed bridges and in other locations that are specified to be cut in the field shall be either sawed or sheared; flame cutting is prohibited.

C. All bending shall conform to the Specification tolerances modified to cover requirements as specified in the Contract Documents.

3.4 SHIPPING, HANDLING, AND PROTECTION OF MATERIAL

A. Reinforcement steel bars shall be shipped in standard bundles and tagged and marked in conformance with the provisions of the code of standard practice of the Concrete Reinforcing Steel Institute. Bundles shall be kept intact and material undamaged and properly identified until ready for use.

B. Coated steel shall be bundled together for shipment using excelsior or other materials as approved by the Engineer and banded using plastic or padded metal bands. All lifting shall be performed in a safe manner and multiple supports consisting of a sufficient quantity of straps or slings to prohibit abrasion within the bundle from excessive bending or distortion.

C. Regardless of the type of surface the bundles are to be stored upon, all bundles shall be stored at the site on suitable blocking or platforms at least four inches (4″) above the surface or vegetation. They shall be kept free from vegetation growth, accumulations of dirt, oil, or other foreign material. Blocking shall be sufficiently close to avoid bending and distortion of the bars. Any distortion of the bars or damage to epoxy coating shall be

corrected as directed by the Engineer at no additional cost to the City. Damage to the epoxy coating shall be touched up. A compatible touch up system shall be provided for repair of defects, all areas damaged during erection, and all visible open areas. Touch up shall be applied by the Contractor as follows:

1. The coating shall be applied directly to the metal surface, which shall be clean, dry, and free of rust and scale. Blast clean to National Association of Corrosion Engineers (NACE) near white where possible. Grease, oil, etc., shall be removed with suitable solvents. The cleaned surface shall be coated before oxidation occurs.
2. Mix ratio of Part A to Part B shall be as recommended by the manufacturer. The two (2) parts shall be thoroughly mixed until a uniform color is achieved. If thinning is required, each part shall be thinned separately with thinner recommended by the manufacturer. Material not used within the shelf life recommended by the manufacturer shall be discarded.

D. Epoxy coated bars shall be adequately covered for protection from ultraviolet rays from the time of delivery if stored outside for more than ninety (90) days.

3.5 PLACING AND FASTENING

A. All reinforcement steel, including dowel bars, shall be accurately placed in the position specified in the Contract Documents or Working Drawings, and firmly held during the depositing and setting of the concrete. Inserting reinforcement steel or dowel bars into plastic concrete is prohibited.

B. Bars shall be tied at all intersections except alternate intersections need not be tied where spacing is less than one foot (1′) in each direction. On bridge decks and the top slabs of box culverts, all intersections shall be tied in the top mat of reinforcement. Reinforcement steel bars embedded in concrete shall not be bent after they are in place.

C. Before any concrete is placed, all mortar shall be cleaned from the reinforcement. Concrete shall not be placed until reinforcement bars are inspected and approved by the Engineer. This shall not relieve the Contractor of the responsibility for any shifting of the bars during the placement of concrete.

D. Reinforcement bars shall be supported and their distances from faces of forms shall be maintained by means of approved templates, blocks, ties, hangers, or other supports. Bars in the bottom of footings shall be supported on approved precast concrete blocks with embedded tie wires or suspended in place. Bars in the tops of footings shall be supported by supports that are approved by the Engineer.

E. Metal, metal with plastic tipped legs, or plastic chairs shall not be used against formed surfaces that will be exposed in the finished structure.

F. A final visual inspection of epoxy coated steel at the construction site will be made by the Engineer after the steel is in place and immediately prior to placing the concrete. Any areas designated by the Engineer that requires repair shall be patched with epoxy in conformance with paragraph 2.1, E, 3 of this Specification. Concrete shall not be placed on a patched area until the patching material is cured for one (1) hour. The Contractor shall allow the Engineer four (4) hours of normal working time after the reinforcement and forms are in place to conduct the inspection.

3.6 WIRE MESH

Wire mesh shall be used where indicated on the Contract Document, around the flanges of girders, floor beams, etc., which are to be encased in concrete or gunited. The wire mesh or welded fabric shall be cut in sheets of proper size, and the separate sheets shall be bent carefully over a template in such a manner as to follow closely the outline of the member to be covered. During the forming of the mesh, breaking of the welds should be avoided and shall constitute cause for rejection if the member of broken welds exceeds one percent (1%) of the total number of joints. Unless otherwise shown on the Contract Documents, the mesh shall generally be spaced one-half inch (1/2″) away from the surface of the encased members. Sheets of mesh shall overlay each other at least two (2) squares. The wire mesh shall be secured at each end and edge with heavy gage annealed wire. If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before installation.

3.7 SPLICING

A. Bars shall be furnished in the lengths and spliced as specified in the Contract Documents and approved shop drawings. There shall be no additional splicing of bars without written approval of the Engineer. Lap splices shall be made with the bars in contact and wired together.

B. Welding of reinforcement steel or attachments thereto is not permitted without written authorization by the Engineer.

3.8 TYING NEW CONCRETE INTO EXISTING CONCRETE

A. On all projects where portions of existing structures are to be used in the finished structure and existing concrete is to be removed, the existing reinforcement steel to be incorporated in the final structure shall be straightened and cleaned. Care shall be taken not to damage these bars.

B. Any exposed existing reinforcement steel that is to be incorporated into the final structure:

1. That has lost twenty percent (20%) or more of its original cross sectional area as determined by the Engineer, shall be cut out. A new bar of the same diameter shall be provided and placed so as to have the minimum required lap at each end of the new bar, or modified as per 3.
2. Where the required bar lap length is available, it shall be used as a dowel.
3. Where the required bar lap is not available or limits of concrete removal to achieve bar lap are too great, a welded or approved mechanical splice shall be provided.

C. All existing reinforcement steel extending into an area in which epoxy coated reinforcement steel is required shall be abrasive blast cleaned and epoxy coated with the touch up system.

D. If expected reinforcement steel is missing, or a pattern differing from that shown on the existing Contract Documents is uncovered, then the Engineer shall be contacted for evaluation.

E. Where dowel bars are required to tie new concrete into an existing structure, holes shall be drilled only in the solid portion of the existing structure. Drilled holes are prohibited at points where cracks exist. Drilled holes shall be a minimum of six inches (6″) from the

face of any masonry surface. The minimum size of dowel bars shall be No. 6. The holes shall be drilled at least one-half inch (1/2″) larger than the outside diameter of the insert to be grouted. Holes shall be cleaned and then filled two-thirds full of grout. The insert shall be placed and allowed to set for twenty-four (24) hours.

3.9 SUBSTITUTION

Substitution of different size bars will be permitted only when approved by the Engineer. No additional compensation will be allowed for substituting larger size bars in lieu of the bars specified.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for cleaning, coating, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Reinforcement steel bars or epoxy coated reinforcement steel bars will not be measured but the cost will be incidental to other pertinent items specified unless an item for reinforcement steel bars appears in the Contract Documents.

C. Reinforcement steel bars or epoxy coated reinforcement steel bars will not be measured but will be paid for at the pertinent Contract lump sum price.

D. Reinforcement steel bars or epoxy coated reinforcement steel bars will be measured and paid for at the Contract Unit Price per pound based on the original approved overall lengths of bars computed on the basis of the nominal unit weight per linear foot.

E. Incorporating existing reinforcing steel in the final structure including straightening, bending, splicing, and removal and replacement will not be measured but the cost will be included in the pertinent concrete item.

F. Wire mesh reinforcement will not be measured but the cost will be incidental to other pertinent items specified.

03 30 00 CAST-IN-PLACE CONCRETE

03 30 00 PORTLAND CEMENT CONCRETE STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing concrete structures or portions of structures including the furnishing, transporting, mixing, placing, curing, and finishing of the portland cement concrete and protecting the structures as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Materials: Curing materials shall be burlap cloth, sheet materials, liquid membrane forming compounds, or cotton mats.

1. Burlap cloth shall be made from jute or kenaf and conform to M 182, Class 1, 2, or 3.
2. Sheet material shall conform to M 171 with the following exceptions:

   a. White Opaque Burlap Polyethylene Sheeting. Tensile strength and elongation requirements are waived. The sheeting shall have a finished product weight of not less than ten (10) oz/yd^2.
   b. White Opaque Polyethylene Backed Nonwoven Fabric. The material shall conform to a. (above), with the thickness requirement waived. The finished product weight shall be a minimum of five (5) oz/yd^2.
   c. White Opaque Polyethylene Film. Tensile strength and elongation requirements are waived.

3. Liquid membrane forming compounds shall conform to M 148. Field control testing of the white pigmented curing compounds shall be on the basis of weight per gallon. The samples shall not deviate more than plus or minus three-tenths (± 0.3) lb/gal from the original source sample.
4. Cotton mats shall consist of a filling material of cotton bats or bats covered with unsized cloth and tufted or stitched to maintain the shape and stability of the unit under job conditions of handling.

   a. The covering shall be either cotton cloth, burlap or jute having the following properties:

      1) Cotton cloth covering shall weigh not less than six (6.0) oz/yd^2 and shall have an average of not less than thirty-two (32) threads/inch of warp and not less than twenty-eight (28) threads/inch of filling. The raw material used in the manufacture of the cotton cloth shall be raw cotton, cotton comber waste, cotton card strip waste, or combinations thereof.
      2) Burlap or jute covering for cotton mats shall weigh not less than six and four-tenths (6.4) oz/yd^2 and shall have not less than of eight (8) threads/inch of warp and not less than eight (8) threads/inch of filling. It shall be the grade known commercially as "firsts" and shall be free from avoidable imperfections in manufacture and from defects or blemishes affecting the serviceability.

   b. The filling material for the mats shall be a cotton bat, or bats made of raw cotton, cotton waste, cotton linters, or combinations thereof, and shall weigh not less than twelve (12) oz/yd^2.

B. Form Release Compound

1. Form release compounds shall effectively prevent the bond of the concrete to the forms. The form release compounds shall not cause discoloration of the concrete or adversely affect the quality or rate of hardening at the interface of the forms.

2. The flash point of the form release compound shall be a minimum of one hundred degrees (100°) F when tested as specified in T 73.

C. Coarse and Fine Aggregate. The grading requirements for coarse aggregate and fine aggregate are shown in Table A. The physical properties for coarse aggregate and fine aggregate are shown in Table B.

D. Cement. Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 153 and T 131, respectively. Blended hydraulic cement shall conform to M 240, Type I (PM) or a Type IP containing fifteen to twenty-five percent (15% to 25%) pozzolan by weight of cement. Maximum loss on ignition shall be three percent (3.0%) and ground iron blast furnace slag shall not be used for blending. The requirement for a manufacturer's written statement of the chemical composition is waived.

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T27															
MATERIAL		**SIEVE SIZE**													
		1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
COARSE AGGREGATE - PORTLAND CEMENT CONCRETE	57 and UNDERDRAIN (a)	100	95–100	—	25–60	—	0–10	0–5	—	—	—	—	—	—	—
	67	—	100	90–100	—	20–55	0–10	0–5	—	—	—	—	—	—	—
	7	—	—	100	90–100	40–70	0–15	0–5	—	—	—	—	—	—	—
FINE AGGREGATE — PORTLAND CEMENT CONCRETE, UNDERDRAIN, and PNEUMATIC MORTAR (b)		—	—	—	—	100	95–100	—	—	45–85	—	—	5–30	0–10	—
COARSE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	100	90–100	—	10–50	0–15	—	—	—	—	—	—	—	—
FINE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE (b)		—	—	—	—	100	85–100	—	—	40–80	—	—	10–35	5–25	—
FINE AGGREGATE/SAND MORTAR and EPOXIES (b)		—	—	—	—	—	100	95–100	—	—	—	—	—	0–25	0–10
MINERAL FILLER		—	—	—	—	—	—	—	—	—	100	—	95–100	—	70–100
CRUSHED GLASS (c)		—	—	100	—	—	0–55	—	—	45–85	—	—	—	0–10	—

Note: (a) When this material is used for drainage applications, recycled concrete shall not be used.
Note: (b) Fine aggregate includes natural or manufactured sand.
Note: (c) Crushed glass shall not contain more than one percent contaminants by weight.

TABLE B – AGGREGATE PHYSICAL PROPERTY REQUIREMENTS											
		TEST METHOD									
MATERIAL TYPE I	**SPECIFICATION**	T90	T 104	T 112	T 113	T 112 & T 113	T 11	T 113	D 4791 (a)	T 96	T 21
		PI	SODIUM SULFATE SOUNDNESS	CLAY LUMPS & FRIABLE PARTICLES	CHERT LESS THAN 2.40 Sp Gr	SUM OF CLAY LUMPS, FRIABLE PARTICLES & CHERT	MATERIAL FINER THAN No. 200 SIEVE	COAL & LIGNITE	FLAT & ELONGATED	LOS ANGELES ABRASION	ORGANIC IMPURITIES
		max	% max	% max	% max	% max	% max	% max	% max	% max	max
COARSE AGGREGATE: CC (a)	M 80 CLASS A	—	12	2.0	3.0	3.0	1.0(e)	0.5	12	50	—
FINE AGGREGATE: PCC (a)(b)	M 6 CLASS B	—	10	3.0	—	—	4.0(f)	1.0	—	—	3.0
COARSE AGGREGATE: LIGHTWEIGHT PCC	M 195	—	—	2.0	—	—	—	—	12	—	—
FINE AGGREGATE: LIGHTWEIGHT PCC (c)	M 195	—	—	2.0	—	—	—	—	—	—	3.0
FINE AGGREGATE/ SAND MORTAR & EPOXIES	M 45	—	10	1.0	—	—	—	0.5	—	—	3.0
MINERAL FILLER (d)	M 17	NP	—	—	—	—	—	—	—	—	—
CRUSHED GLASS	M 80	—	12	—	—	—	—	—	—	45	—

Note: (a) Coarse and fine aggregate for PCC shall not contain more than one percent (1%) contaminants by weight.

Note: (b) In areas exposed to traffic manufactured sand shall have a minimum ultimate polish value of eight (8), based on the parent rock.

Note: (c) Fine aggregate conforming to M 6 may be used if the lightweight concrete does not exceed the maximum unit weight specified in the Contract Documents.

Note: (d) Fly ash shall have a maximum of twelve percent (12%) loss on ignition.

Note: (e) One point five (1.5) if material passing No. 200 sieve is dust of fracture, free of clay or shale.

Note: (f) Five point zero (5.0) for concrete not subject to surface abrasion.

TABLE C – PORTLAND CEMENT CONCRETE MIXTURES									
MIX NO.	28 DAY SPECIFIED COMPRESSIVE STRENGTH psi	STANDARD DEVIATION psi	CRITICAL VALUE psi	MIN CEMENT FACTOR lb/yd^3	COARSE AGGREGATE SIZE M 43	MAX WATER/ CEMENT RATIO by wt	SLUMP RANGE inch	TOTAL AIR CONTENT %	CONCRETE TEMPERATURE °F
1	2500	375	2430	455	57, 67	0.55	2 – 5	5 – 8	70 ± 20
2	3000	450	3010	530	57, 67	0.50	2 – 5	5 – 8	70 ± 20
3	3500	525	3600	580	57, 67	0.50	2 – 5	5 – 8	70 ± 20
4	3500	525	3600	615	57, 67	0.55	4 – 8	N/A	70 ± 20
5	3500	525	3600	580	7	0.50	2 – 5	5 – 8	70 ± 20
6	4500	675	4770	615	57, 67	0.45	2 – 5	5 – 8	65 ± 15
7	4200	630	4420	580	57	0.50	1-1/2 - 3 2-1/2 max if slip-formed	5 – 8	70 ± 20
8	4000	600	4180	750	7	0.42	1 – 3	5 – 8	65 ± 15

Note: 1 When concrete is exposed to water exceeding fifteen thousand (15000) ppm sodium chloride content, Type II cement shall be used. In lieu of a Type II cement, a Type I cement may be used in combined form with an amount of up to fifty percent (50%) replacement with ground iron blast furnace slag, or an amount of up to twenty-five percent (25%) replacement with Class F fly ash. The Contractor shall submit to the Engineer the proposed mix proportions and satisfactory test results in conformance with C 1012 showing a sulfate resistance expansion not exceeding point one-tenth of one percent (0.10%) at one hundred eighty (180) days.

Note: 2 The temperature of Mix No. 6 when used for other than superstructure Work as defined in TC-1.02 shall be seventy degrees (70°) plus or minus twenty degrees (± 20°) F.

Note: 3 When synthetic fibers are used, the slump shall not exceed five inches (5″).

Note: 4 Nonchloride Type C admixtures may be used when approved by the Engineer.

Note: 5 If a high range water reducing admixture Type F or Type G is used, the slump requirement shall be four to eight inches (4″ to 8″).

Note: 6 Type A or D admixture shall be added to bridge, box culvert, and retaining wall concrete.

E. Concrete Admixtures shall not contribute more than two hundred (200) ppm of chlorides based on the cement content when tested as specified in Maryland Standard Methods of Testing (MSMT) 610. Only prequalified admixtures shall be used. A pozzolan and Type I (PM) or Type IP cement shall not be used in the same mix. Since the strength gains are delayed with these materials, a longer period of time may be required for curing and form removal.

1. Air Entraining Admixtures. Air entraining admixtures shall conform to M 154.
2. Chemical Admixtures. Chemical admixtures shall conform to M 194, Type A, D, or nonchloride C.
3. High Range Water Reducing Admixtures. High range water reducing admixtures shall be liquid and shall conform to M 194, except that the water content shall be a maximum of eighty-five percent (85%) of that of the control, and the durability factor shall be a minimum of ninety (90). Type F shall be used for early strength and shall produce a minimum compressive strength in twelve (12) hours of 180 percent of that of the control. Type G shall be used when early strength is not specified. The manufacturer shall furnish certification as specified in TC-1.02. The certification shall include curves indicating the fluid ounces of admixture per 100 lb of cement as related to water reduction and strength gain for twelve (12) hours when used with a minimum cement factor of seven hundred (700) lb.
4. Pozzolans. The Contractor may request the use of pozzolans to control alkali silica reactivity or for other reasons. When a pozzolan is used, the minimum cement factor and water/cement ratio shall be determined on the basis of the combined weight of cement and pozzolan. See the following Table D for percentage of fly ash, ground iron blast furnace slag, and microsilica.

    a. Fly Ash. Fly ash shall conform to M 295, pozzolan Class C or F, except that the maximum permissible moisture content shall be one percent (1.0%), and when used in concrete Mix Nos. 3 and 6 the loss on ignition shall not exceed three percent (3.0%).
    b. Ground Iron Blast Furnace Slag. Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.
    c. Microsilica. Microsilica shall conform to C 1240, except that the oversize requirement is waived.

5. Ground Iron Blast Furnace Slag. The Contractor may request to substitute a maximum of fifty percent (50%) of the weight of cement with ground iron blast furnace slag. When ground iron blast furnace slag is used, the minimum cement factor and water/cement ratio will be determined on the basis of the combined weight of the cement and ground iron blast furnace slag. Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.
6. Synthetic Fibers. When synthetic fibers are specified in the Contract Documents, the fibers shall be one-half inch to one and one-half inch (1/2″ to 1-1/2″) long and conform to C 1116, Type III. The manufacturer shall furnish certification as specified in TC-1.02. The quantity of fibers used and their point of introduction into the mix shall conform to the fiber manufacturer's recommendations.

F. Water. Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in

mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed the following limits:

Bridge Superstructure and Prestressed Concrete	500	ppm
Latex Modified Concrete	50	ppm
Other Concrete and water used in curing	1000	ppm

G. Concrete Mixes

1. Portland cement concrete shall conform to the applicable portions of 03 30 43, (Production Plants) and the following:
2. Prior to the start of construction, the Contractor shall submit to the Engineer the source and proportions of materials to be used for each concrete mix.
3. The concrete, with the exception of water and chemical admixtures, shall be proportioned by weight. Water and chemical admixtures may be proportioned by volume or weight. The mix shall be uniform and workable.
4. The concrete mixes shall conform to the aforementioned Table C.
5. Coarse and fine aggregate tested for alkali silica reactivity (ASR) having an expansion up to one-tenth of one percent (0.10%) may be used without restriction. Those having an expansion greater than or equal to thirty-five hundredths percent (0.35%) shall not be used. Aggregates having an expansion greater than one-tenth of one percent (0.10%) but less than thirty-five hundredths of one percent (0.35%) shall be considered reactive and shall only be used when one of the following options is employed:

TABLE D

OPTION	ALKALI CONTENT OF CEMENT % MAX	REPLACE CEMENT WITH		SPECIFICATION
		MATERIAL	% BY WEIGHT	
1	1.50	Class F Fly Ash	15 – 25	M 295
2	1.50	Ground Iron Blast Furnace Slag	25 – 50	M 302 Grade 100 or 120
3	1.50	Microsilica	5 – 7	C 1240
4	—	Blended Cement (a)	100	M 240
5	0.60 (b)	Low Alkali Cement	100	M 85

Note: (a) Pozzolan content of fifteen to twenty-five percent (15% to 25%) by weight of cement.

Note: (b) For mixes (Mix 6 Modified, Twelve (12) Hour Patch Mix) used for portland cement concrete pavement repairs; the maximum allowable percentage of alkalis in portland cement shall be seven-tenths of one percent (0.70%).

6. When reactive aggregate is used, the Contractor shall designate which option will be used to control the formation of the ASR gel. If an option other than option 5 in Table D above is chosen, the Contractor shall conduct tests as specified in Maryland standard Methods of Tests (MSMT) 212 using the reactive aggregate and the proposed cementitious material. For approval, the expansion test results shall not be greater than one-tenth of one percent (0.10%). When more than one reactive aggregate is used in a concrete mix, each shall be tested individually and the maximum amount of pozzolan required to reduce the expansion of all the

aggregates to less than or equal to one-tenth of one percent (0.10%) shall be used. The Contractor shall submit to the Engineer the aggregate source, test results, and the percent and type of replacement cement. The Engineer may withhold source approval pending verification testing.

7. A trial batch will be prepared to certify that each mix conforms to the requirements as specified in the following paragraph 10 and 11. Approval will be given when the test results conform to the minimum required average strength.

8. The Contractor shall make arrangements with the Engineer, at least two (2) weeks in advance, to have an authorized representative present during the batching and testing. Each trial batch shall consist of at least three (3) yd^3 of concrete. All materials, equipment, and labor required to produce the trial batches and conduct the required tests shall be supplied at no additional cost to the City.

9. The requirement for a trial batch may be waived by the Engineer when past performance records show that the required average strength requirement has been met.

10. Design Required Average Strength. The required average strength (fcr') shall be the larger of:

$$f'_{cr} = f'_c + (1.34 \times S) \text{ or}$$
$$f'_{cr} = f'_c + (2.33 \times S) - 500$$

where:

f'_c = the twenty-four (28) day specified compressive strength.
S = the standard deviation as specified in the following tables.
A test is defined as the average strength of two (2) companion cylinders.

11. Standard Deviation.

a. When past performance records are available, a standard deviation shall be established from documented performance records of the producer consisting of a minimum of fifteen (15), consecutive twenty-eight (28) day compressive strength tests obtained within the last twelve (12) months. The standard deviation shall be established as the product of the calculated standard deviation and multiplier.

NUMBER OF TESTS	MULTIPLIER FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

Interpolate for intermediate number of tests.

b. When past performance records are not available, the required average strength shall conform to the following:

SPECIFIED COMPRESSIVE STRENGTH fc', psi	REQUIRED AVERAGE COMPRESSIVE STRENGTH fcr', psi
Less than 3000	fc' + 750
3000 – 4000	fc' + 1000
4001– 5000	fc' + 1200
over 5000	fc' + 1400

12. Standard of Control. The average of all sets of three (3) consecutive strength tests shall equal or exceed the critical value as specified in paragraph 10 and 11 which shall be computed using the following formula:

Critical Value = fc' + (1.14 X S) – 500

13. Failure to conform to these criteria shall be cause for immediate investigation and remedial action up to and including suspension of production. A design standard deviation equal to fifteen percent (15%) of the specified strength shall be used for calculation until a minimum of fifteen (15) test results are obtained.

14. The actual average strength and standard deviation shall be computed upon the availability of twenty-eight (28) day strength data comprising a minimum of fifteen (15) tests. Should this determination indicate an excessive margin of safety, the concrete mix may be modified to produce lower average strength as approved by the Engineer. If these calculations indicate a coefficient of variation greater than fifteen (15), the quality of the concrete and testing will be evaluated.

15. Testing. Sampling shall conform to T 141. Testing shall be performed as follows:

TEST	METHOD	MINIMUM TEST FREQUENCY
Slump	T 119	1 per 50 yd^3 (or fraction thereof)
Air Content	T 152 T 196	1 per 50 yd^3 (or fraction thereof)
Compression	T 23	1 per 50 yd^3 (or fraction thereof)
Compression Mix No. 7 Only	T 23	3 per Day

Note: 1 Compressive strength tests are defined as the average of two (2) companion cylinders.

Note: 2 A second test will be made if the first slump or air content test fails. Acceptance or rejection will be based on the results of the second test.

Note: 3 When constructing plain and reinforced concrete pavements, the testing frequency for slump and air content shall be one (1) per one hundred (100) yd^3 or fraction thereof.

16. Concrete will be acceptable if both of the following requirements are met:

a. The average of all sets of three (3) consecutive strength tests equal or exceed the specified design strength.

b. No individual strength test (average of two (2) companion cylinders) falls below the specified design strength by more than five hundred (500) psi.

17. A price adjustment will be based on the Contract Unit Price per cubic yard of concrete. If the unit is a lump sum item, the price per cubic yard for the concrete will be determined by dividing the cubic yards into the Contract lump sum price.

a. Test results more than five hundred (500) psi below the specified design strength: Failing strength tests will be considered individually with a price adjustment being applied on the percentage basis as shown below.

(Price per yd^3) X (quantity of yd^3 represented by the failing concrete strength) X (percent of failure).

Example:

\$400.00 per yd^3 X 50 yd^3 X [1 – (3600/4500 psi)] = \$4,000.00

1) No payment will be allowed when the test results fall below fifty percent (50%) of the specified design strength for structural concrete or forty percent (40%) for incidental concrete.
2) The Engineer will determine when the strength of the concrete represented by the failing tests is sufficient to remain in place or whether it must be removed and replaced with Specification concrete.

b. Test results five hundred (500) psi or less below the specified design strength: Strength failures five hundred (500) psi or less than the specified design strength will be averaged with the next two (2) consecutive tests. If those two (2) tests include a failure greater than five hundred (500) psi, those tests will be evaluated as per previous paragraph "a" and replaced with the next consecutive test. If the resulting average falls below the specified design strength, a price adjustment will be applied in conformance with the table below. Any failure will only be included in one grouping.

STRENGTH BELOW THE SPECIFIED DESIGN LEVEL, psi (avg of 3 tests) Mix No. 1 thru Mix No. 7	**ADJUSTMENT FACTOR**
1 – 100	0.005
101 – 200	0.01
201 – 300	0.02
301 – 400	0.04
401 – 500	0.08

Adjustment price equals (price per yd^3) X (quantity of yd^3 represented by the failing cylinders) X (the adjustment factor).

Example:

\$400.00 per yd^3 X 50 yd^3 X 0.01 = \$200.00

H. Grout: Mortar used for grouting anchor bolts, pipe, handrail posts, and miscellaneous items shall be composed in conformance with one of the following:

1. One (1) part portland cement or blended hydraulic cement and one (1) part mortar sand by dry loose volume.
2. Prepared bag mixes consisting of portland cement or blended hydraulic cement and mortar sand. The prepared mixes shall produce a mortar conforming to the strength requirements specified in the Contract Documents.

3. Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of five thousand (5000) psi in seven (7) days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of zero percent (0.0%) after seven (7) days when tested as specified in T 160.

4. Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of sixty five hundred (6500) psi in seventy-two (72) hours when tested as specified in Maryland Standard Methods of Tests (MSMT) 501.

5. The natural or manufactured sand for epoxy grout shall conform to the following:

TABLE E – AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27									
MATERIAL	SIEVE SIZE								
	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
FINE AGGREGATE/ SAND MORTAR and EPOXIES	100	95–100	—	—	—	—	—	0–25	0–10

6. An epoxy or polyester anchoring system may be used when approved by the Engineer in conformance with the manufacturer's recommendations. Strength values shall be as specified in the Contract Documents.

I. Linseed Oil: Linseed oil shall consist of a mixture (by volume) of fifty percent (50%) boiled linseed oil conforming to Federal Specification TT-L-190 and fifty percent (50%) kerosene conforming to D 3699.

J. Drains, Downspouts, Weep holes and Pipes: The drains, downspouts, weep holes and pipes shall conform to the following Table F. The manufacturer shall furnish certification for all pipes, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

TABLE F		
MATERIAL	SPECIFICATION	REMARKS
Corrugated Polyethylene Pipe	M 294	12-inch to 48-inch diameter.
Corrugated Polyethylene Drainage Pipe	M 252	Perforated underdrain and underdrain outlet pipe.
Polyvinyl Chloride (PVC) Profile Wall Pipe	M 304	12-inch to 48-inch diameter.
Polyvinyl Chloride (PVC) Pipe	AASHTO Bridge Section 18 PVC Ribbed Pipe	—
	M 278 (a)	Underdrain outlet pipe.
	M 278 (a)	Perforated underdrain.
Concrete Drain Tile	M 178	—

Note: (a) Perforations shall conform to the requirements of F 758.

K. Reinforcement: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices, shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents.

1. The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss.
2. Epoxy coatings shall conform to D 3963.
3. Material used for the touch up system shall be a two (2)-part epoxy system designated and color matched for patching the epoxy coating used.
4. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.
5. The manufacturer shall furnish certification as specified previously.

L. Cast Iron Scuppers: Iron castings shall conform to A 48, Class 30B.

M. Anchor Bolts: Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.

N. Steel Forms Which Remain in Place: Steel bridge deck forms and deck form supports which remain in place shall be fabricated from steel conforming to A 653, Designation SS, Grades 33 through 80, Coating Designation G 165. The minimum thickness of uncoated steel shall be three-hundred fifty-nine ten-thousandths inch (0.0359″).

O. Joint Sealer:

1. Joint sealer and crack filler shall conform to D 3405 as modified by Maryland Standard Methods of Testing (MSMT) 404. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.
2. Manufacturer's recommendations regarding heating and pouring temperatures will be used when testing these materials. If a range of temperatures is recommended, the midpoint will be used as the pour point.
3. Silicone joint sealer and crack filler shall be low modulus, one (1) component compound, which may or may not, require a primer for bonding to concrete. If a primer is required, it shall be as recommended by the sealant manufacturer and shall be placed on the joint faces following the insertion of the backup material.
4. Silicone material, when tested at seventy three degrees (73°) F, plus or minus three degrees (± 3°) F and forty-five to fifty percent (45% to 55%) relative humidity, shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Shore A Hardness, at 7 days	D 2240	10-25
Tensile Strength at 150% Elongation, psi max	D 412, Die C	45
Elongation, % min	D 412, Die C	700
Adhesion in Peel, lb/inch min	Federal Spec TT-S-00230	20
Flow, 0.01 inch max	T 187	0.3
Tack-Free Time, minutes	D 2377	20-75

5. Each container of silicone sealer and crack filler shall have a minimum shelf life of six (6) months. Material more than six (6) months old shall be retested.

P. Preformed Joint Fillers: Preformed joint fillers shall conform to M 153. The bituminous fiber type shall conform to M 213, with the bitumen content determined using T 164. The weathering test shall be deleted for either type of material.

Q. Preformed Joint Inserts: Preformed inserts shall conform to M 220.

R. Preformed Elastomeric Joint Seals:

1. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.
2. Roadway seals for concrete pavement shall conform to M 220.
3. Bridge seals shall conform to M 297.
4. The minimum depth of all seals measured at the contact surface shall be at least ninety percent (90%) of the minimum uncompressed width of the seal.
5. The lubricant adhesive shall be compatible with the preformed joint seals and concrete. The Engineer will determine if consistency is suitable at the time of installation.
6. The manufacturer shall furnish certification showing that lubricant adhesive conforms to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, D 1084, Method B, CP min	25000
Film Strength, D 412, psi min	2000
Elongation, D 412, % min	250

7. No lubricant adhesive shall be used after nine (9) months from the date of manufacture. Each container shall be plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture.

S. Water Stops and Flashing:

1. Water stops shall be made of rubber or polyvinyl chloride (PVC).
2. The water stop shall be of the shape and dimensions specified in the Contract Documents. The cross section shall be uniform along its length and transversely

symmetrical so that the thickness at any given distance from either edge of the water stop shall be uniform.

3. The water stop shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Tensile Strength, D 412, psi min	2000
Elongation @ Break, D 412, % min	300
Hardness, Rubber, Type A durometer, D 2240	55 ± 5
Hardness, PVC, Type A durometer, D 2240	75 ± 5

4. The Contractor shall furnish a test sample for each lot or shipment of water stop. The manufacturer shall furnish certification as specified in the previous paragraph.
5. Sheet metal for flashing shall be of a material and gauge as specified in the Contract Documents.
6. Copper shall conform to the weight per square foot and gauge requirements of B 152.
7. Galvanized sheets shall conform to A 653, Coating Designation G 90.

T. Production Plants, Refer to 03 30 43, (Production Plants).

U. Fusion Bonded Epoxy:

1. The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents.
2. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss.
3. Epoxy coatings shall conform to D 3963.
4. Material used for the touch up system shall be a two (2)-part epoxy system designated and color matched for patching the epoxy coating used.
5. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five (35°) F ambient.
6. The manufacturer shall furnish certification as specified.
7. Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed the following limits:

    a. Bridge superstructure and prestressed concrete, five hundred (500) ppm,
    b. Latex modified concrete, fifty (50) ppm,
    c. Other concrete and water used in curing, one thousand (1000) ppm.

V. Epoxy Bonding Compound:

1. Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and contain no volatile solvents, lumps, or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging.
2. The manufacturer shall furnish certification of actual test results for each required property of the type, grade, and class of epoxy submitted, and shall accompany each sample.
3. The manufacturer shall supply actual bond test results for each batch submitted for use.
4. Admixtures:

   Calcium chloride or any other admixtures containing chloride salts shall not be used in the concrete placed on steel bridge deck forms which remain in place.

5. Requirements for Accessories:

   All accessories such as inserts and ties that will remain in completed superstructures within the top five inches (5″) of final deck slab concrete shall be either epoxy coated or made of material other than aluminum that will not rust. All accessories that will remain in parapets, sidewalks or any other portion of the structure designated to have epoxy coated reinforcement steel shall also conform to these requirements. Inserts are prohibited in the top half of slabs exposed to vehicular traffic unless specified in the Contract Documents.

6. Precast Reinforced Concrete Box Sections:

   a. Precast reinforced concrete box sections for culverts shall conform to M 259 or M 273 including concrete design strength. All details shall be as specified in the Contract Documents. Construction joints between the walls and the bottom and top slabs will be optional.
   b. Certification from the manufacturer for each shipment of precast units is required. A copy of the certification shall be delivered to the Engineer, the Laboratory, and the Contractor with each shipment. One (1) copy shall remain at the plant. The certification shall contain the name and address of the manufacturer, the type of structure, the identification number, the date of manufacture, the date of shipment, a statement indicating conformance with the Specifications, and the signature of the quality control manager. Noted on the unit shall be the station number and designation, the identification number, the name or trademark of the manufacturer, the date manufactured, and a stamp indicating conformance with the Specifications.
   c. No precast unit shall be shipped unless it has been tested and is shown to be in full compliance with the Contract Documents.
   d. The placement and consolidation of the required bedding under the unit shall be a minimum six inches (6″) of No. 57 aggregate unless otherwise directed by the Engineer.

7. Composition of Concrete Mixes for Slip Form:

If the slip form method is used for constructing concrete parapets and concrete median barriers on bridges, the concrete shall conform to Mix No. 6 except that the slump shall be one inch (1″) maximum. The slump shall be measured at the placement point as the concrete is being charged into the slip form machine. The coarse aggregate shall be crushed stone conforming to M 43, size number 7, and shall not be less than sixty-three percent (63%) of the total aggregate in the mix. Other size coarse aggregate may be used provided the Engineer approves the slip form results.

PART 3 EXECUTION

3.1 GENERAL

Concrete shall be made either at the Work site or away from the Work site by an approved central mixing plant, or by approved truck mixing as specified in 03 30 43, (Production Plants).

3.2 EQUIPMENT

The Contractor shall use equipment of sufficient capacity to complete any unit or section of concrete between construction joints, as specified in the Contract Documents, in one continuous operation consistent with placement operations as approved by the Engineer. Hand mixing may be permitted with written approval of the Engineer for small volumes of concrete. However, its intended use is for small isolated areas where structural integrity is not critical and the volume does not exceed one (1) yd^3.

3.3 FORMS

A. Design Criteria.

1. Design Loads. Design loads shall conform to American Association of State Highway and Transportation (AASHTO) Standard Specifications for Highway Bridges, Temporary Works, and Loads. The lumber in the forms shall be assumed to weigh fifty (50) lb/ft^3.
2. Design Stresses:

a. Timber Design. Timber design for formwork shall conform to ACI Standard Recommended Practices for Concrete Formwork (ACI 347). Unit stresses stipulated in AASHTO for treated timber may be increased by twenty-five percent (25%) but shall not exceed the values listed below. Deflections for form members shall not exceed 1/270 of the span or 1/4 inch.

Compression perpendicular to grain	450 psi
Compression parallel to grain	1600 psi
Flexural stress	1800 psi
Horizontal shear beams up to six inches (6″) deep	200 psi
Beams over 6 inches deep	150 psi
Axial tension	1200 psi

3. Plywood. The strength of plywood without backing shall be calculated based on the grain of the face plies running parallel to its span. The plywood shall be installed in this manner.
4. Steel Members for Forms. Steel design for formwork shall conform to AASHTO Standard Specifications for Highway Bridges. For design where no dynamic loading is involved, the AISC Standard Manual of Steel Construction, Allowable Stress Design may be used as the accepted design code.
5. Steel Forms Which Remain in Place. The maximum deflection of steel deck forms that remain in place shall not exceed one, 1/180 of the span and not in excess of one-half inch (1/2″).

    a. For steel deck forms that remain in place, camber shall not be used to compensate for deflection in excess of the above limits. The design spans of the form sheets shall be the clear distance between beam or girder flanges less two (2) inches.
    b. For steel forms which remain in place, the unit working stress in the steel sheet and supporting members shall not be more than seven-hundred twenty-five thousandths (0.725) of the specified minimum yield strength of the material furnished but not to exceed thirty-six thousand (36,000) psi. Physical design properties shall be computed in conformance with the American Iron and Steel Institute Specification for Design of Cold Formed Steel Structural Members.

B. Working Drawing Approval. Detail, form, falsework and centering plans and design loads shall be submitted to the Engineer for approval except as specified otherwise in the Contract Documents. Working Drawings for forms shall include all members proposed for use as well as form ties and bracing. Details for form ties shall not be submitted separately but shall be incorporated in the general Working Drawings submittal. The rate of placing concrete shall be noted on the Working Drawings. Approval of the Working Drawings will not relieve the Contractor of responsibility in connection with them. The provisions of 05 12 00, (Structural Metal Framing) also apply when Working Drawings are submitted for falsework and centering.

C. Forms at Construction Joints and Corners. Ties or bolts shall be provided three to six inches (3″ to 6″) from each side of concrete construction joints for tightening the forms against the hardened adjacent concrete prior to placing fresh concrete. At joints where forms have been removed and reconstructed, the form surface shall extend over the concrete already in place; and the forms shall be drawn tightly against the previously placed concrete prior to placing the fresh concrete. Forms shall be filleted at all sharp corners, except when otherwise specified in the Contract Documents and shall be given a bevel or draft in the case of all projections. All exposed corners of concrete shall be chamfered with three-quarters inch by three-quarters inch (3/4″ X 3/4″) milled chamfer strips, except on unexposed footings or where specified in the Contract Documents.

D. Form Scaffolds and Platforms. Form scaffolds and platforms shall be built along the outside of bridge deck fascias during construction of forms for bridge decks. They shall be designed and constructed as an integral part of the form supports. Separate design calculations shall be furnished with the Working Drawing submission. Approval of the Working Drawings will not relieve the Contractor of responsibility in connection with them.

E. Forms for Unexposed Surfaces. All sheathing, studs and bracing shall be of sound material. Studs and wales shall be straight and true and surfaced on two (2) edges to a

uniform width. The inside face of the forms shall be of sufficiently smooth construction that the resulting concrete surfaces shall be accurately formed.

F. Forms for Exposed Surfaces. Unless otherwise specified in the Contract Documents, steel forms which remain in place shall be used between stringers to support the bridge deck concrete, except in panels where a longitudinal deck construction joint is located between stringers. Forms to be used on the structure for widening and rehabilitation shall provide that the exposed finished concrete surfaces shall match the existing structure.

1. Lined Forms for Exposed Surfaces. Contact surfaces of lined forms for surfaces exposed to weather or view shall be approved composition board, sanded plywood or metal. All studs shall be surfaced two (2) edges to a uniform width and shall be of a grade of lumber that is solid, straight and free of defects that could impair its strength. The backing for form lining shall be constructed using a grade of form lumber that is solid, straight and free of defects that could impair its strength, but need not be of the quality used for contact forms for unexposed surfaces.
2. All sheathing for form backing shall be surfaced two (2) sides to a uniform minimum of the thickness of at least the dimension approved on the Working Drawings. Form sheathing shall be built solidly, securely nailed to studs and placed to prevent any bulging of the lining.
3. Unlined Forms for Exposed Surfaces. Unlined forms in contact with surfaces exposed to weather or view shall be constructed of five (5) ply sanded plywood of the thickness specified in the Contract Documents. Plywood shall be manufactured especially for concrete formwork using waterproof glue. All studs and wales shall be surfaced two (2) edges to a uniform width.
4. Full size sheets of plywood shall be used except where smaller pieces cover an entire area. All joints shall be backed solidly to prevent leakage and the edges of abutting sheets shall be nailed to the same stud or blocking with sixpenny nails not more than eight inches (8″) apart. Where rustication occurs, horizontal joints in the plywood shall be constructed behind a rustication strip. Otherwise, horizontal joints shall be placed at the same respective elevations in all portions of the structure. Where vertical rustication occurs, vertical joints in the lining shall be constructed behind a rustication strip. Otherwise, vertical joints shall be kept to a minimum and shall be butted tightly together and sealed with a crack filler specified in the Contract Documents, as the plywood is nailed in place.

G. Steel Forms Which Remain in Place.

1. Installation. The surface of the steel forms in contact with concrete shall be smooth and free of surface irregularities. Working Drawings for steel forms which remain in place shall specify the grade of steel, the physical and sectional properties for all permanent steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.
2. Form supports shall not be welded to flanges of steel that are not considered weldable or to portions of flanges that are subject to tensile stresses.
3. Welding and welds shall conform to the provisions of the latest American Welding Society (AWS) Bridge Welding Code pertaining to fillet welds.
4. Unless otherwise specified in the Contract Documents, steel forms which remain in place shall be used between stringers to support bridge deck concrete, except in panels where a longitudinal deck construction joint is located between stringers.
5. Procedure Check and Inspection. The Contractor shall remove at least one section of the forms at a location and time selected by the Engineer from each

span of each bridge in the Contract. If the bridge has a longitudinal joint, a form on each side of the joint shall be removed from each span. This should be done as soon after placing the concrete as practical to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there have been any changes in the concrete mix or in the Contractor's procedures warranting additional inspection.

6. At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and ensure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing, and other defects. If irregularities are found and the Engineer determines that these irregularities do not justify rejection of the Work, the concrete shall be repaired as directed by the Engineer. The concrete shall be given an ordinary surface finish in conformance with the following paragraph 3.8 A. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab. The Contractor's method of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed and replaced or repaired as directed by the Engineer at no additional cost to the City.
7. The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

H. Steel Forms Which Do Not Remain in Place. The surface of the steel forms in contact with the concrete shall be smooth and free of bolts, bolt heads, nuts, rivet heads, welding seams and surface irregularities. Forms that produce unacceptable concrete surfaces will be rejected and shall not be reused.

1. For Round Columns and Piers: Steel forms for round columns and piers shall have minimum number of horizontal joints and shall be column height. The minimum thickness of these steel forms shall be ten (10) gauge.
2. For Pier Caps and Crash Walls: Prefabricated girder type steel forms may be used for forming pier caps or crash walls. Each element of these forms, including side, bottom and end shall be in one (1) piece where practical. Splices shall be arranged to provide a symmetrical pattern where forms are spliced.
3. For Reinforced Concrete Box Culverts and Rigid Frames: Steel forms or forms constructed of wood or composition wood panel sheathing set in metal frames may be used. The minimum thickness of steel forms for box culverts and rigid frames shall be ten (10) gauge.

I. Fiber Column Forms. Fiber column forms shall only be used for round columns, and shall conform to these Specifications. The forms shall produce columns truly round and straight and shall be protected from dampness before concrete is placed. Fiber forms shall not be spliced.

J. Release Agents. All forms shall be treated with form release compound immediately before placing concrete.

K. Temporary Supports. Temporary supports used for centering and falsework shall be built on good firm foundations. Unless otherwise provided, they shall be founded to bear upon strata at or below the frost line unless rock is available, or piling shall be driven for support where required. The strength and bracing of the temporary supports shall ensure that the

completed structure will have the shape shown on the Contract Documents. The Contractor shall employ jacks or hardwood wedges in connection with the temporary supports in order to take up settlement either before or during placing of concrete. Temporary supports shall be set to give the structural camber specified on the Contract Documents, plus allowance for shrinkage and settlement. If during the construction any weakness, settlement or distortion develops, the Work shall be stopped and any masonry affected thereby removed and the temporary structures strengthened before Work is resumed. Centering shall be constructed to permit its gradual, uniform lowering.

L. Defective Forms. Removal or modification of steel forms which remain in place shall be performed using a device approved by the Engineer. Burning is prohibited.

M. Form Ties. Only form ties approved by the Engineer shall be used. Ties shall leave no metal closer than two inches (2″) from the surface. They shall not be fitted with lugs, cones, washers or other devices which act as spreaders within the form or for any purpose that leaves a hole larger than seven-eighths inch (7/8″) diameter. When prefabricated steel girder forms are used, tapered ties up to one and one half-inch (1-1/2″) maximum diameter shall be used. Ties shall be clean and free of rust. When ties are removed, the holes shall be pressure grouted with a nonshrink mortar mixed to match the color and texture of the concrete.

N. Portions of ties to be removed from the concrete shall be coated with a clear lubricant or other approved material to facilitate removal. Care shall be exercised during removal of form ties to avoid spalling the concrete on the exposed surface. Cutting back from the face is prohibited.

O. Form Support Brackets or Devices. Devices attached to previously placed concrete may be used, provided all parts are acceptable to the Engineer. No metal part of an insert, threader or anchor that remains in place in the concrete shall be within two and one- half inches (2-1/2″) of the surface. The concrete supporting the brackets or other devices shall be cured and shall have attained a minimum compressive strength of three thousand (3000) psi before the brackets or other devices are attached. All voids left in the concrete after brackets or other devices have been removed, shall be no greater than two inches (2”) diameter and shall be completely filled with mortar and the surface finished as specified in the following paragraph 3.8 A.

P. Form Removal. For the purpose of determining the time when falsework and forms may be removed, backfill placed, and when loads may be applied to structures, an adequate number of concrete test specimens shall be made in addition to those required to check the quality of the concrete being produced. All forms for concrete Work shall be removed and disposed of by the Contractor after formwork requirements have been conformed to, except those that are specified to remain in place.

Q. Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their support shall not be removed without the approval of the Engineer. Supports shall be removed in a manner that permits the concrete to uniformly and gradually take the stresses due to its own weight.

R. Year Built Marking. The year of completion shall be cast into each structure, as determined by the Engineer. Forms or molds for casting the year built numerals in the structure shall be supplied by the Contractor. The year built numerals shall be the size specified in the Contract Documents.

3.4 ANCHOR BOLT PLACEMENT

A. No anchor bolts shall be cast in the concrete. The Contractor shall create a template to locate the anchor bolt holes. This template shall be used to shift the reinforcement prior to placing the concrete to eliminate conflicts between the reinforcement and the anchor bolt holes.

B. Anchor bolts shall be set in round holes drilled or cast in the concrete. Bolts shall be accurately positioned by using templates set to correct location and alignment to ensure proper span lengths, and tops of bolts shall be carefully set to proper elevation. Unless otherwise noted, bolts shall be installed plumb or normal to the finished bearing surface of the masonry.

C. Bolts set in holes drilled or cast into the concrete shall have the portion below the bridge seat swedged. The drilled or cast holes shall have a diameter at least one inch (1″) larger than the bolt diameter.

D. Anchor bolts, nuts, and washers shall not be painted.

E. After anchor bolts are finally and correctly positioned, the holes shall be completely filled with grout. Grouting of anchor bolts is not permitted until all structural steel is set in its final position. After the masonry plates or shoes are set, the space between the bolts and the round holes through fixed plates or shoes shall be filled with the same material. Slotted holes in expansion devices shall remain unfilled unless otherwise specified in the Contract Documents.

F. The Contractor shall maintain a minimum air temperature of forty degrees (40°) F around the mortar surface for a period of three (3) days unless otherwise recommended by the manufacturer.

G. When mortar filling is used for bolts inserted in holes drilled or cast in the concrete, the holes shall first be checked for depth by inserting and withdrawing the bolts. They shall then be partially filled with mortar into which the bolts shall be forced by uniform pressure or light blows from a hammer (flogging and running is prohibited) so that excess mortar is pushed out at the top of the hole. The excess mortar shall be removed.

H. Bolts shall be set to project approximately one-half inch (1/2″) above the nut and shall be threaded to approximately one-half inch (1/2″) below the nut in their final position.

I. Rockers or expansion plates with slotted holes shall be set with the proper tilt or offset as determined by the temperature prevailing at the time and so that they will be in their midway position at sixty-eight degrees (68°) F or as specified in the Contract Documents.

3.5 CONCRETING

A. Before placing concrete, forms shall be cleaned. Struts, stays and braces serving temporarily to hold the forms in correct shape and alignment shall not be buried in the concrete. If faces of completed or proposed excavated footing areas are disturbed prior to concreting, the footings shall be extended at no additional cost to the City to bear on undisturbed faces acceptable to the Engineer.

B. All concrete except tremie concrete shall be placed in the dry.

1. Foundations. The Contractor shall be responsible for any reinforcement fabricated prior to approval of foundations. If bearing material varies more than assumed in design, footing may be lowered, raised, deepened, subfoundation placed, piles used or a combination of these methods used to best obtain bearing as directed by the Engineer. If planned footings are changed vertically, reinforcement steel shall be revised as required. Subfoundation concrete for bridges, retaining walls and wing walls of box culverts or rigid frames shall be constructed using plain Concrete Mix No. 1 (no reinforcement). The Concrete Mix No. 1 need not be vibrated, and the usual curing and cold weather requirements may be reduced to three (3) days. Selected backfill using number 57 aggregate may be used for subfoundation for box culvert barrels, headwalls and miscellaneous structures.
2. Concrete Placement. Concrete shall be placed to avoid segregation of the material and the displacement of the reinforcement. The use of troughs, chutes and pipes for conveying concrete more than fifteen feet (15′) from the mixer to the forms will be permitted only when acceptable to the Engineer. Open troughs and chutes shall be metal or metal lined. Where segregation occurs due to steep slopes, chutes shall be equipped with baffles.
3. Where placing operations would involve dropping the concrete more than five feet (5′), it shall be deposited through a tube made of sheet metal, canvas or other approved material. Aluminum hoppers or tubes are prohibited. Lower ends shall be kept as close as possible to the newly placed concrete and not more than three feet (3′) above the concrete. All tubes shall have a minimum diameter of six inches (6″) unless otherwise directed by the Engineer. After initial set of the concrete, the form shall not be disturbed, and no strain shall be placed on the projecting ends of the reinforcement. Concrete shall be placed in horizontal layers not more than twelve inches (12″) high except as provided herein. When less than the complete area of a layer is placed in one (1) operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and vibrated before the preceding layer has taken initial set to prevent injury to the concrete and avoid separation of joints between the layers. Concrete in columns and walls shall be placed in one (1) continuous operation unless otherwise directed. The concrete shall set at least twelve (12) hours before the caps are placed.
4. Where walls, piers, columns, struts and posts have horizontal construction joints, succeeding lifts shall not be placed until the lower placement has set for twelve (12) hours. Prior to subsequent placement, all accumulations of mortar splashed upon the reinforcement shall be cleaned. Care shall be exercised not to injure or break the concrete seal bond near and at the surface of the concrete while cleaning the reinforcement steel.
5. Grade Controls for Bridge Deck Slabs. Bridge deck slabs supported by new stringers shall be placed in conformance with the specified line and grade. The Contractor shall take all necessary precautions, including a check on all new bridge seat elevations as the last order of Work before setting stringers. Any adjustments resulting from this check shall be completed before additional Work is started. After the structural steel is set, a final check of elevations of all the steel stringers at points corresponding to those specified in the Contract Documents for dead load deflection and finished roadway elevations shall be made. Computations shall be made by the Contractor, reviewed by the Engineer, and controls set at proper elevations to produce finished tops of concrete bridge decks that will be true as to planned line and grade of the roadway surface.

a. Grade control for bridge deck slab replacements shall conform to the 02 41 16.33, (Bridge Demolition).

6. Superstructure Placement Restrictions. The superstructure shall not be erected until the substructure forms have been sufficiently stripped to determine the character of the concrete in the entire substructure, unless otherwise permitted by the Engineer. In all spans, the concrete bridge deck slabs outside of the stringers shall be cast using plywood forms.

a. Unless otherwise specified in the Contract Documents, concrete for deck slabs shall be pumped whenever the volume of concrete in the pour exceeds fifty (50) yd^3.
b. The Contractor shall place all superstructure concrete in conformance with the following schedule:

SUPERSTRUCTURE CONCRETE PLACEMENT SCHEDULE		
DATES	**BEGIN CONCRETE PLACEMENT AFTER**	**FINISH BURLAP PLACEMENT BEFORE**
May 15 - June 15	7:00 PM	11:00 AM
June 16 - Aug. 14	9:00 PM	7:00 AM
Aug. 15 - Sept. 15	7:00 PM	11:00 AM
Sept. 16 - May 14	No time restrictions	

c. Superstructure concrete shall not be placed or worked in any manner when the temperature in an unshaded location at the placement site is above eighty degrees (80°) F. Floodlighting shall be used when existing light is less than twenty (20) average horizontal ft-c over the construction area.
d. The Contractor shall submit a situation plan to the Engineer showing the locations and aiming of floodlights. After reviewing this plan, the Engineer will witness a test of the floodlighting system at the proposed construction area. The Contractor shall run the floodlighting test. The floodlighting system shall be capable of maintaining twenty (20)ft-candles without producing a glare on traffic. Floodlighting systems will be approved by the Engineer. When portable generators are used, an emergency backup system shall be available at all times on the job site.

7. Rate of Concreting for Bridge Deck Slabs. Provisions shall be made by the Contractor to ensure that the placement rate of concrete is thirty-five (35) yd^3/hour minimum. Under special circumstances, the Engineer may give written approval to lower this requirement.

a. The Contractor shall submit for the Engineer's approval written evidence of an adequate source of concrete, and placing and finishing equipment capable of conforming to the minimum rate of placement of thirty-five (35) yd^3/hour per crew while providing the intended quality finish. This evidence shall be submitted at least one (1) week prior to the proposed placement of the bridge deck slab.
b. Concrete in slab spans shall be placed in one (continuous operation and in one (1) layer for each span, unless otherwise directed by the Engineer.

c. Concrete shall not be mounded on concrete slab forms supported by beams, stringers, or girders. When placing, the concrete shall be distributed to a depth not exceeding the planned slab thickness plus six inches (6″) before spreading, consolidating and finishing.

d. The placing sequence shall be in the numerical order specified in the Contract Documents and shall not be modified. A minimum of forty (40) hours shall lapse between the completion of one placement and the start of the next numbered placement.

8. Box Culverts. Box culverts shall be constructed by casting in place or using precast reinforced concrete box culvert sections. Whenever a particular method is indicated in the Contract Documents, the Contractor may elect to use the alternate method unless otherwise specified. However, all time constraints such as maintenance of traffic, curing, completion dates, etc., shall be met. If the Contractor elects to use precast reinforced concrete box sections, at least fifteen feet (15′) of all box culvert ends and all footings, wing walls, headwalls and toe walls shall be cast in place. Additionally, the precast sections shall terminate a minimum of one foot (1′) from all footings and toe walls. All lifting devices shall be indicated on the Working Drawings and all lifting holes shall be filled with nonshrink grout after the precast units are in place. The precast reinforced concrete box sections shall be set tightly together and the joints shall be sealed in conformance with the manufacturer's recommendations. The bottom slabs of portland cement concrete structures box culverts shall be placed for their full depth in one mass or layer and permitted to set not less than twelve (12) hours before any additional Work is done. Single cell box culverts spanning in excess of ten feet (10′) and multiple cell box culverts shall not have the top slabs placed until the concrete in the sidewalls has set for a minimum of twelve (12) hours. Construction joints at the top of sidewalls may be omitted in some cases provided the top slabs are placed as follows:

a. For single cell box culverts spanning ten feet (10′) or less, the sidewall construction joint may be omitted and the top slab placed on the sidewalls, provided the concrete in the sidewalls is allowed to set for approximately two (2) hours before starting to place the top slab.

b. Regardless of size or number of cells, the Contractor may request in writing to place the top slab on the walls of box culverts in conformance with number 6 above. The written proposed plan, including rate and method of placement, and type and size of equipment, shall be submitted to the Engineer for approval. If the Contractor receives initial written approval, the first section of the structure shall serve as a demonstration to confirm that there is no excessive cracking or any other detriment, and that satisfactory results will be obtained. After receiving written final approval, the Contractor may continue placing the remainder of the box culvert. If at any time the Engineer decides that the results are no longer satisfactory, the Contractor shall revert to placing the concrete with the twelve (12) hour delay as specified above at no additional cost to the City.

9. Forming Concrete Parapets and Median Barriers on Bridges. The Contractor may construct concrete parapets and median barriers on bridges by either the slip form method or conventional fixed form method. The slip form method is prohibited on bridges maintaining traffic or on parapets when railing is specified. Contractors who elect to use the slip form method shall first demonstrate their ability to produce

results acceptable to the Engineer. If a Contractor is unable to demonstrate that ability or fails to maintain acceptable results during production, the slip form operation shall be stopped, the unacceptable Work shall be removed and the construction methods shall be modified. If construction modifications do not produce acceptable results, the Contractor shall use the fixed form method. No additional compensation will be permitted, and no increase will be allowed in any Contract Price nor will any revisions be made to the amount of time to complete the Contract as a result of any required removals, modifications or changes in the method of placing parapets or barriers. The Contractor shall notify the Engineer in writing of the proposed method of constructing the parapets and median barriers prior to beginning superstructure Work. If slip forming is to be considered, then the following shall apply:

a. The Contractor shall submit to the Engineer evidence of being capable of producing high quality slip formwork. Prior to beginning any slip form construction, the Contractor shall submit a detailed work plan. The plan shall include the type of equipment, materials and procedures to be used, any Subcontractors involved in the construction, key personnel who will be performing the Work (names, training, experience, etc.), as well as detailed information on how the Contractor proposes to satisfactorily complete the Work.

b. When possible the work plan shall include reference to at least three (3) other similar projects completed in the State of Maryland or surrounding states using the slip forming method for parapet or median barrier construction. As far as practical, these similar projects shall have been built using the same equipment, personnel, material, and procedures proposed for the project. The Engineer may elect to visit these completed projects to evaluate the acceptability of the finished product.

c. If the Engineer determines that the Contractor has satisfactorily slip formed parapets or median barriers at the locations submitted in the Contractor's work plan, the requirements of the off bridge test site specified below may be waived and the first fifty feet (50′) of slip forming on the bridge will be considered the test section for the structure. This test section shall be completed and approved prior to placing the remaining portions of parapet or bridge median barrier.

d. The work plan shall be approved in writing prior to beginning any slip forming operation.

e. Any proposed revisions or deviations to the approved work plan submitted by the Contractor shall be approved by the Engineer in writing prior to making the change.

f. If the Contractor does not conform to number nine (9) above, an off bridge test section shall be completed and accepted prior to placing any portion of the parapet or bridge median barrier. The Contractor shall place the appropriate test section of parapet or median barrier using the same equipment, sensor line, support spacing, material, personnel and procedures as described in the work plan. This test section shall match the structure's horizontal curve as much as practical, be a minimum of fifty feet (50′) long, and be placed at a location selected by the Contractor near the bridge site.

g. The off bridge test section shall be placed with vertical irregularities varying upward and downward at least three-quarters inch (3/4″). The Contractor

shall then prove that the method of slip forming can compensate for this deviation and provide a top of parapet or median barrier that is true to the proposed line and grade and not necessarily parallel to top of bridge deck. This will necessitate that the equipment provide for variations in height of vertical face of parapet where it intersects the top of deck slab.

h. The sensor line shall be positioned, supported, and spaced in the same manner in the testing operation as will be used on the bridge decks with no stakes, holes, etc., used to support it. Sensor support spacing shall be as recommended by the slip form machine manufacturer and as necessary to maintain the planned line and grade. The rate of slip forming on the test section shall be the same as that proposed for the bridge. Joints shall be saw-cut in the test section at the same approximate spacing and in the same manner as proposed for the finished bridge.

i. The Engineer will evaluate the procedure, material, equipment and appearance of the test section. The Contractor shall take three (3) test cores from the test section at locations directed by the Engineer to determine the concrete quality. Honeycombing, sags, tears or other evidence of poor quality concrete will be cause for rejection of the test section. If the test section is rejected, the Contractor may place additional test sections until approved by the Engineer or may elect to use the fixed form method.

j. The accepted test section shall remain in place until all parapets or median barriers on the bridges are complete. The slip formed parapets and median barriers on the bridges will be compared to the approved test section to ensure that similar acceptable structures are being achieved on the bridges. Following completion and acceptance of all bridge parapets and median barriers, the Contractor shall remove and dispose of the off bridge test section.

k. The entire testing procedure, including removing and disposing of test units, regardless of whether the procedure is approved or rejected, shall be done at no additional cost to the City.

l. When dual bridges are separated by a joint, the two (2) parapets that make up the median barrier shall be constructed in separate operations. Constructing both sections of median barrier simultaneously is prohibited. The first median parapet section shall be allowed to cure for a minimum of forty (40) hours prior to constructing the second section of median parapet.

m. Additional reinforcement steel shall be placed to provide bracing for the reinforcement in the parapet to prevent displacement when subjected to the pressure developed in the slip form machine's extruding process. A detail will be included in the Contract Documents. The alignment and rigidity of the reinforcement steel will be strictly enforced by the Engineer to ensure that the minimum clearances shown on the Contract Documents for concrete cover are maintained.

n. The Contractor shall ensure that a continuous supply of concrete is available at the bridge site during slip forming operations, and that an uninterrupted flow of concrete is provided to the slip form machine. Once the slip form machine is set in motion, it shall keep advancing until it reaches the proposed stopping point. The Contractor shall organize and schedule the operations in a manner that the next concrete truck will be able to move into position at the slip form machine as soon as the previous truck pulls away without interrupting the machine's uniform advancement.

Under no circumstances will the Contractor be allowed to operate the slip forming in a manner which requires a concrete truck to be removed from the bridge before another truck can move into place.

o. Vehicular traffic, except for the slip form machine and its concrete supply trucks, is prohibited on the bridge while slip forming operations are in progress.

p. When the slip form machine is set up and the sensor wire is placed, a dry run of the equipment shall be made in the presence of the Engineer to ensure that the parapet or median barrier will envelop preset obstacles that are to be embedded or meet with flush surfaces such as pull boxes, expansion joint plates, etc.

q. The concrete consistency shall maintain the shape of the structure without support after the extrusion. The surface shall be free of surface pits larger than three-sixteenths inch (3/16″) diameter. The concrete shall require no further finishing, other than light brushing with water only. Finishing with brush applications of grout is prohibited.

r. If a tear occurs at the top of the parapet or median barrier during the slip forming operation, it shall be repaired immediately. The repair shall be made in a workmanlike manner in conformance with good concrete practices acceptable to the Engineer. The repair shall blend into the barrier to the extent that the naked eye cannot distinguish any difference in the wall face or top.

s. The rate at which the slip form machine is advanced is crucial to the quality of the finished parapet or median barrier. The Contractor shall ensure that the rate of advancement conforms to the equipment manufacturer's recommended value. The advancement of the slip forming machine on the bridges shall be the same rate as used on the approved test section. A higher or lower rate is prohibited.

t. The shape of the finished parapet or median barrier shall conform to the dimensions shown on the Contract Documents. The vertical face at the bottom of the concrete safety shaped parapets or median barriers is three inches (3″) high, and will be unacceptable if this vertical face exceeds three and one-half inches (3-1/2″). The finished parapet or median barrier shall show no deviation from the proposed grade and alignment in excess of one-quarter inch per ten foot length (1/4″/10′).

u. Joints shall be saw cut in the finished parapet or median barrier using a diamond blade. Cuts shall be one-eighth inch (1/8″) wide and two inches (2″) deep and shall be made in the top, outside and inside faces, stopping three inches (3″) above the top of deck slab in both faces except where it is impossible for the outside portion of the final placement of back to back median parapets. Joints shall be spaced as shown on the Contract Documents. Reinforcement steel in the parapets and median barriers shall be terminated at the joint locations. The deck shall be marked to ensure that the saw cuts are made at these locations and do not conflict with the reinforcing steel pattern. The trapezoidal shaped control joints on the outside of parapets will not be required if slip forming is used. Slip form placements shall only be terminated at a parapet control joint. The joints shall be saw cut as soon as possible after initial concrete set and after the concrete has set sufficiently to preclude raveling during the sawing. The sawing shall be completed the same day the concrete is extruded and

before any shrinkage cracking has occurred. Concrete shall not be left overnight without saw cutting the joints.

v. When portions of the bridges are in super elevation with varying rates of slope, the Contractor shall produce the exact configuration of parapets and median barriers as shown on the Contract Documents, i.e., level top surface, wall normal to deck surface, etc.

10. Temperature Controls. Concrete temperatures shall be as specified in aforementioned Table A. Concrete below these temperatures shall be heated by one of the following methods:

a. When the method of heated mixing water is used, the water shall not be above one-hundred seventy degrees (170°) F when introduced into the mix.

b. When the method of heated aggregates is used, aggregates containing frozen lumps shall be independently heated and no materials containing frozen lumps, ice, or snow shall be permitted to enter the mixer. Aggregates may be heated by steam coils or other dry heat but not by discharging live steam or hot water into them. Heating by means of a flamethrower or any direct flame is prohibited.

c. When the ambient air temperature is below forty degrees (40°) F, the temperature of the air in contact with the reinforcement shall be raised to forty degrees (40°) F prior to placing concrete. When the ambient air temperature is above seventy degrees (70°) F and the reinforcement is exposed to the direct rays of the sun, the reinforcement shall be cooled to seventy degrees (70°) F or less by means of a water spray prior to placing concrete. When the ambient air temperature is above seventy degrees (70°) F and the steel forms that remain in place are exposed to the direct rays of the sun, the forms shall be cooled by means of water spray prior to placing concrete.

d. When abnormal wind or storms are forecast locally by the National Weather Service, superstructure concrete shall not be placed during the period covered by the forecast.

11. Pumping. Equipment shall be suitable and adequate in capacity for the Work and will be acceptable to the Engineer. The equipment shall be arranged so that no vibrations result which might damage freshly placed concrete. No parts of the pump or discharge line shall be made of aluminum.

12. Use of Conveyors. Concrete may be moved from the mixer to its final position by use of conveyors. Conveyors shall be in sections and concrete shall be deposited from one (1) conveyor belt onto the next through a hopper. The maximum rise on any individual section of the conveyor is thirty degrees (30°) F from the horizontal. The maximum belt travel speed shall be nine hundred (900) ft/minute for concrete slumps less than two inches (2″). This speed shall be decreased for slumps exceeding two inches (2″). Conveyors used for placement of decks shall be supported by main load carrying members. Polyethylene or other material acceptable to the Engineer shall be placed under the conveyor line to contain any spillage from the belts onto the deck.

3.6 DEPOSITING CONCRETE UNDER WATER

A. Concrete shall not be deposited in water or exposed to the action of water before setting, unless specified in the Contract Documents or approved by the Engineer in writing.

Concrete deposited under water shall be placed by means of a tremie pipe. The tremie pipe shall not be less than ten inches (10″) diameter and shall be equipped with a watertight plug.

B. The bottom of the pipe shall be equipped with a baffle or deflector plate. The number and location of pipes will be dependent on the size of the pour. After tremie concrete has been placed, it shall not be disturbed nor shall successive layers be placed on top until the previously placed concrete has developed the necessary strength as determined by the Engineer. Concrete shall not be deposited in water where the temperature is less than thirty-five degrees (35°) F. When concrete is deposited in water thirty-five degrees to forty-five degrees (36° to 45°) F, the concrete shall be heated and placed at a temperature of sixty degrees to eighty degrees (60° to 80°) F. Pumping of water is prohibited while concrete is being placed. The consistency of the concrete shall be carefully regulated to prevent segregation. Tremie concrete which projects more than six inches (6″) above the top of the as-planned tremie concrete shall be cut down at no additional cost to the City until no portion is more than six inches (6″) above the as planned elevation.

1. Cofferdams. Where cofferdams are used, separate forms shall be constructed within the cofferdams except where footing concrete is to be placed against a base of undisturbed material and where the cofferdam is to remain in place and act as the concrete form. The water level in the space between form and cofferdam shall be kept below the bottom elevation of concrete for at least twelve (12) hours.
2. Concrete Seals. When feasible, concrete seals for parts of structures under water shall be placed continuously from start to finish so as to avoid horizontal construction joints. The surface of the concrete shall be kept as nearly horizontal as practicable at all times to ensure thorough bonding. In these cases, each succeeding layer of the seal shall be placed before the preceding layer has taken its initial set. The slump of tremie concrete shall be maintained between four inches and eight inches (4″ and 8″) and maintained as close to four inches (4″) as possible. After dewatering and prior to placing any succeeding layers of concrete, the top of the foundation seal (tremie concrete) shall be thoroughly cleaned.
3. Concrete Exposed to Saline Water. Saline water shall not come in direct contact with the concrete until it has been permitted to harden as required in the following table:

CONCRETE IN SALINE WATER	
Saline Content of water by weight in parts per thousand	Saline water shall not contact concrete until following minimum time in days has elapsed after initial set*
0 to 10	0
10+ to 15	7
15+ to 20	14
20+ to 25	21
Over 25	30

* The Engineer may approve a waiver in writing.

Unless otherwise specified, the concrete shall be wet cured for at least seven (7) days while being maintained at a temperature of fifty degrees (50°) F or above.

3.7 CONSOLIDATION

A. All concrete except concrete deposited under water shall be consolidated by means of internal vibrators unless otherwise directed by the Engineer. These provisions shall also apply to precast members or units.

B. Vibration shall be applied at points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective.

1. Internal Vibration: Internal vibrators shall be of a type and design approved by the Engineer. The intensity of application shall visibly affect a mass of concrete of one inch (1″) slump over a radius of at least eighteen inches (18″) and have frequency of vibration not less than forty-five hundred (4500) impulses per minute.
2. External Vibration: External vibrators shall be of a type and design approved by the Engineer. External vibration shall be used as directed by the Engineer for the following sections: very thin, very heavily reinforced, numerous inserts, or where form surfaces are sharply inclined or battered. Filler concrete for steel grid floors shall be consolidated using external vibrators to the steel grid.

3.8 FINISHING CONCRETE SURFACES

A. Concrete faces shall be finished with one of the following types. All concrete Work shall have an ordinary surface finish as described below unless otherwise specified.

1. Ordinary Surface: Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those that are not to be exposed or not to be waterproofed. On all surfaces, broken corners or edges and any cavities shall be thoroughly cleaned and, after having been kept moist, shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Any excess mortar at the surface of the concrete shall be removed. The mortar patches shall be cured as specified in the following paragraph. Construction and expansion joints in the completed Work shall be carefully tooled and cleaned. Joint filler shall be exposed for its full length with clean and true edges. Resulting surfaces shall be true and uniform. Surfaces that cannot be repaired in a manner acceptable to the Engineer shall be completed as special surface finishes.
2. Special Surface: Fins and projections shall be removed. The surface of the concrete shall then be saturated with water and kept wet for a minimum of two (2) hours. A grout mix of the same proportions as the concrete shall be thoroughly rubbed onto the surface by section using burlap pads or cork floats completely filling all voids, pits, and irregularities. After this grout has dried sufficiently, the excess shall be wiped off with dry, clean burlap. The surface shall then be cured as specified in the following paragraph except that only colorless liquid curing compound shall be used in this method. The exterior faces of cast-in-place superstructures and end posts for bridges over highways and all interior faces of cast-in-place parapets, bridge median barriers, and end posts shall receive this type of finish. This finish shall not be applied to members that have been constructed by the slip form method.
3. Horizontal Surfaces: All upper horizontal surfaces such as the tops of parapets, copings, and bridge seats shall be finished by placing an excess of concrete material in the forms and striking off even with a wood template. Tops of handrail

(posts and caps), headwalls, parapets, wing walls, and barriers shall be steel troweled to a smooth, dense surface.

4. The bridge seat bearing areas of the substructure masonry shall be finished to the elevations shown on the Contract Documents. The Contractor shall check the elevation of each bearing area prior to finishing to ensure conformance. Each area shall be checked for level in all directions using a spirit level and adjustments made prior to the setting of the concrete. The area shall be steel troweled to a dense flat surface. Bearing areas that are not flat after final finishing shall be ground to achieve an acceptable surface.
5. Bearing areas will be rejected whenever the elevation is below that of the surrounding masonry.
6. Bridge Deck Slabs: Concrete for bridge decks shall be transversely screeded with a power operated cylinder or roller finishing machine approved by the Engineer. The finishing machine and all transverse construction joints shall be set parallel to the nearest support lines (the abutment or pier) on all bridge deck slabs. When the skew angle changes at supports, the screed angle shall be adjusted accordingly as the finishing machine progresses across the deck slab. The concrete shall be placed so that the front edge of the newly placed concrete is as nearly as possible parallel to the skew of the finishing machine. The concrete shall also be placed uniformly ahead of the finishing machine, and shall not be more than six inches (6″) above the top elevation of the finished deck slab nor more than ten feet (10′) ahead of the finishing machine.
7. Under no circumstances shall the finishing machine span a length greater than the manufacturer's recommendation. The Contractor may combine machines or use two (2) machines of which both may use a common rail and any additional rail. The proposed method and the location and anchorage of accessories that will remain in the completed superstructures as a result of this requirement shall be subject to the approval of the Engineer and conform to 2.1, V, 5. After the concrete has been struck off, the surface shall be checked with a ten feet (10′) straightedge operated in a position parallel to the center line of the structure by means of long handles. This straightedge shall progress longitudinally in overlapping five feet (5′) increments and transversely in two feet (2′) increments to locate any irregularities in the surface. The width of the working face shall not be greater than two inches (2″) and the straightedge shall be as light weight as possible to avoid distortion of the slab surface. The concrete surface shall be finished with a full width strip of burlap mechanically or manually dragged across the surface.
8. Slab Grooving: Grooving shall be performed on all bridge decks including slab bridges, and box culverts built to grade. The grooving operation shall start after the bridge deck slab has been cured in conformance with the following paragraph 3.11 and attained a minimum compressive strength specified in the following paragraph 3.16. The bridge deck shall be grooved perpendicular to the center line.
9. The grooves shall be cut using a mechanical saw device that leaves grooves one-eighth inch (1/8″) wide, three-sixteenths inch (3/16″) plus or minus one-sixteenth inch (± 1/16″) deep and variably spaced from five-eighths inch (5/8″) to seven eighths inch (7/8″) apart. The grooves shall extend across the slab to within one foot (1') of the gutter lines. The transverse grooving shall not cut across armored joints or any joint in which an existing joint seal may be damaged, but shall stay clear by two inches (2″) plus or minus one inch (± 1″) on each side. On joints skewed seventy degrees (70°) F or less, one (1) pass shall be made parallel to the armored joint unless otherwise directed by the Engineer. The residue resulting from grooving

operations shall be removed from all surfaces in a manner acceptable to the Engineer. All surfaces shall be left in a washed and clean condition.

10. Deck Slab Tolerances: Slab thickness shall not be reduced. Any slabs that are found to have deficient thickness may be rejected. The surface shall not deviate in a transverse or longitudinal direction more than one-eighth inch per ten feet (1/8″/10′) from a straight line. For vertical curves the deviation (from the curve specified) shall not exceed one-eighth inch per ten feet (1/8″/10′) in a longitudinal direction. The corrective Work shall be done prior to grooving at no additional cost to the City.
11. Sidewalks and Safety Curbs: The concrete shall be struck off with an approved screed to the elevation and slope specified in the Contract Documents. It shall be wood floated to give a uniformly gritty surface free from depressions or high spots. The joints shall then be edged with the appropriate edging tool. Curbs shall be stripped and finished as soon as possible.
12. Culvert Slabs: The tops of culvert slabs when they are the roadway riding surface shall be finished in conformance with above. Invert slabs and the tops of culvert slabs when they are not part of the roadway, or when they are to be overlaid with hot mix asphalt shall be screeded either by hand or machine and have a float finish. The allowable surface tolerance shall be within one-quarter inch (1/4″) of the grade specified in the Contract Documents. Inverts of culverts, having a span less than ten feet (10′), need not be straightedged.

3.9 CURING

A. These requirements shall apply to curing of all concrete surfaces except bridge deck slabs or top surfaces of culverts with integral wearing surfaces. Curing for bridge deck slabs and top surfaces of culverts with integral wearing surfaces shall be as specified in the following paragraph 3.11.

B. Curing shall start as soon as the concrete has set sufficiently.

C. The requirement for keeping the surfaces wet shall be met even in areas where there is no ready water supply.

1. Culvert invert slabs and all footings shall be cured for five days using the method specified in the following paragraph 3.10, A thru 3.10, D.
2. Vertical surfaces shall be cured in the forms for seven (7) days. However, the forms may be removed after twenty-four (24) hours for structural elements six feet (6′) or less in height, or after forty-eight (48) hours for structural elements greater than six feet (6′) high, with the following provisions. The surface shall be cured as specified in the following paragraph 3.10D for the remainder of the seven (7) day curing period. The forms shall not be removed when cold weather protection is required. Forms, falsework, centering, etc., carrying loads shall remain in place for a minimum of seven (7) days and until the concrete has attained a compressive strength of three thousand (3000) psi. Internal bulkheads used for forming construction joints, etc. may be removed after the concrete has been in place for twenty-four (24) hours if it is necessary to do so to continue the Work without interruption. When a higher strength concrete than specified is used, forms, falsework, centering, etc., carrying loads shall remain in place for three and a half (3-1/2) days and until the concrete has attained a compressive strength of three thousand (3000) psi.

3. Fiber column forms may be removed at times specified above, but no later than ten (10) days after placing concrete.
4. When parapets or median barriers on structures are formed by the slip form method, curing shall begin as specified in the following paragraph 3.10, F using a fugitive dye liquid membrane-forming compound immediately after the concrete is finished. Immediately after each joint is saw cut, the concrete surfaces shall be cured for the remainder of the seven (7) days of cure as specified in the following paragraph 3.10, D.
5. Tops of end walls, end support walls, headwalls, etc., shall be cured for three (3) days with burlap or cotton mats as specified in the following paragraphs 3.10, B or 3.10, D, respectively.
6. Horizontal surfaces shall be cured for seven (7) days as specified in 3.10, B thru 3.10, E.

3.10 CURING METHODS

A. Flooding. Units of structures that will be below water in the completed structure, i.e., bottom slabs of culverts, footings, struts, etc., may be gradually flooded when approved by the Engineer after the concrete is twelve (12) hours old, provided the curing water conforms to the aforementioned 2.1, F. The temperature of this water shall be maintained at thirty-five degrees (35°) F or above for the specified curing time.

B. Burlap. Two (2) layers of burlap shall be used. Successive strips of burlap shall be overlapped a minimum of six inches (6″). The second burlap layer shall be placed not less than forty-five degrees (45°) to the first layer, or in lieu of this, the six inches (6″) overlap of the second layer may be placed midway between the first layer. This material shall be thoroughly saturated by immersion in curing water for at least twenty-four (24) hours prior to placement and shall be kept saturated throughout the time specified for curing.

C. White Opaque Polyethylene Backed Nonwoven Fabric. One (1) layer of white opaque polyethylene backed fabric shall be used. Successive strips shall be overlapped a minimum of six inches (6″). This material shall be thoroughly saturated by immersion in curing water for at least twenty-four (24) hours prior to placement and shall be kept saturated throughout the time specified for curing.

D. Cotton Mats. One (1) layer of cotton mat material shall be used and shall be kept thoroughly saturated with curing water prior to placement and throughout the time specified for curing. The material shall be kept in tight contact with the concrete.

E. White Opaque Burlap Polyethylene or White Opaque Polyethylene Film. The white opaque burlap polyethylene sheeting shall be placed on no less than one (1) layer of wet burlap with the burlap side of the sheeting facing down. White opaque polyethylene film, if used, shall be placed on no less than two (2) layers of wet burlap. Only one (1) layer of cotton mats is required in any usage. These materials may only be used atop the wet burlap or cotton mats on unobstructed flat and reasonably level surfaces.

1. Adjacent mats or sheets shall be lapped no less than one foot (1′). The ends shall be brought down around the sides of the concrete being cured and securely fastened to make an airtight seal.
2. The white opaque burlap polyethylene sheeting or the white opaque polyethylene film shall remain in place for the same length of time as required for burlap or

cotton mats. These protective coverings need not be wetted down; however, the covered burlap or cotton mats shall be kept wet for the time interval specified.

F. Liquid Membrane. Liquid membrane forming compound shall be applied in conformance with manufacturer's recommendation or as directed by the Engineer. The material shall be applied by sprayers and shall be thoroughly agitated before and during use.

3.11 BRIDGE DECK SLABS

A. Bridge deck slabs and culvert top slabs with integral wearing surfaces, including sidewalks, shall be cured as follows:

1. The Contractor shall have misting equipment available. Prior to placement of any concrete, operation of the misting equipment shall be verified by the Engineer to ensure that the equipment and procedure are capable of misting the entire placement area without damaging the fresh concrete. This shall be done at the location of proposed use each day that a deck placement is to be made. Ample spare parts, water, fuel, etc. shall be readily available. A backup tested unit shall also be available.
2. The Contractor shall cover the finished concrete with wet burlap as specified in the previous paragraph 3.10, B. The concrete covering shall progress immediately after the concrete has been finished but no portion of the concrete shall remain uncovered for more than forty-five (45) minutes after placement. Mist spraying shall be used when directed by the Engineer, and when the concrete is not covered with wet burlap within thirty (30) minutes after placement. Once misting is started, it shall continue until wet burlap is completely in place.
3. Use of the mist spray shall not relieve the Contractor of the responsibility for covering the concrete within the forty-five (45) minutes after placement.
4. After the concrete is covered with wet burlap, it shall be cured in conformance with the previous paragraph 3.10, B for the remainder of the seven (7) day period. The two (2) layers of burlap shall be kept continuously and uniformly saturated throughout the curing period. White opaque burlap polyethylene sheeting and white opaque polyethylene film or clear polyethylene film shall not be placed over wet burlap except when approved by the Engineer in writing for cold weather protection. A sufficient quantity of soaker hoses shall be used to conform to these requirements. The Contractor shall take immediate action to remedy improper saturation of any area throughout the entire curing period.
5. The Contractor shall provide a sufficient number of experienced personnel and necessary equipment to ensure proper placement, protection and curing of the concrete in conformance with these Specifications.

B. The Contractor shall also provide temporary troughs, dams, etc., necessary to prohibit the runoff water from reaching any traveled roadway, shoulder or sidewalk. The proposed methods of controlling runoff water in these areas shall be submitted to the Engineer for approval before use. The plan shall include locations of all troughs and dams, as well as the proposed methods of attaching them to any portions of the structure. There shall be no welding or drilling holes in any portion of a permanent member of the structure.

C. After the procedure is underway, it shall be evaluated, and any areas not functioning in a manner acceptable to the Engineer shall be modified by the Contractor to satisfy the requirements for retaining and directing the flow of water.

D. In rehabilitation construction, where the full use of temporary troughs, dams, etc., is not practical, modifications to the provisions for controlling the runoff water shall be made by the Contractor and approved by the Engineer.

3.12 CONSTRUCTION JOINTS

A. Construction joints shall be kept to a minimum and will be permitted only where specified in the Contract Documents, or authorized by the Engineer in writing.

B. The surface of the hardened concrete shall be cleaned and kept moistened until the additional concrete is placed. The top surface of concrete shall be leveled using a grade strip, unless otherwise specified. At chamfers the top surface of the concrete shall be steel troweled adjacent to the chamfer using the top surface for the chamfer strip as a guide.

C. Where a featheredge might be produced at a construction joint, as in the sloped top surface of a wing wall, an inset form shall be used to produce a block in addition to the preceding placement. The inset form shall produce a six inch (6″) minimum edge thickness of concrete in the succeeding placement.

D. The Contractor shall place an epoxy bonding compound on the surface areas of existing concrete (concrete that existed prior to the beginning of the Contract) which will be in contact with new concrete. Epoxy bonding compound shall also be applied to the entire face of all bridge deck slab construction joints. The surfaces to be coated shall be clean, sound, and dry and bonding compound shall be mixed and applied in conformance with the manufacturer's recommendations.

3.13 LINSEED OIL PROTECTIVE COATING

A. Linseed oil protective coating shall be applied to the integral concrete bridge deck slabs, box culvert wearing surfaces and sidewalks on bridges and box culverts when the pertinent linseed oil protective coating item appears in the Contract Documents.

B. Permanent paint or tape lane markings required on the structures shall be placed prior to the application of the linseed oil protective coating. The concrete surfaces to be treated shall also be cured, dried and thoroughly cleaned of all dust, dirt, and deleterious material prior to placing the first linseed oil protective coating.

C. If the concrete is wet, it shall be allowed to dry for one to two (1 to 2) days at a minimum temperature of sixty degrees (60°) F. If the concrete surfaces are extremely dry, the Contractor shall either wet the concrete thoroughly and allow it to dry for one or two (1 or 2) days or apply a third protective coating at the same rate per gallon as the second coat, as directed by the Engineer. The ambient temperature at the time of application shall be fifty degrees (50°) F minimum. Following the second application, the ambient temperature shall be forty degrees (40°) F minimum. Two (2) coats shall be applied on all top surfaces that are not grooved. The first coat shall be applied at a rate of forty (40) yd^2/gal. The second coat shall be applied at a rate of sixty-seven (67) yd^2/gal. On bridge decks and top slabs of box culverts that are grooved, the first coat shall be applied at a rate of twenty-five (25) yd^2/gal. The second coat shall be applied at a rate of forty-five (45) yd^2/gal. The second coat shall not be applied until the first coat is dry. If additional coats are required, there shall be a minimum of twenty-four (24) hours between them. The drying time may be increased as the ambient temperature falls below seventy degrees (70°) F.

3.14 COLD WEATHER PROTECTION

A. Concrete shall be protected and heated after it has been placed when the air temperature in the shade and away from artificial heat drops to forty degrees (40°) F or lower at the time of placing or at any time within the number of days specified herein. Protection and heating shall be as follows:

1. Ordinary concrete shall be protected and kept continuously at a temperature not less than fifty degrees (50°) F for at least seven (7) days following placement.
2. In no case shall concrete be heated to more than one hundred degrees (100°) F. At the end of the heating period, the concrete surfaces shall be cooled to the temperature of the outside air by slowly reducing the artificial heat at a uniform rate until the temperature of the outside air is reached within a twenty-four (24) hour period.
3. The Contractor shall have tarpaulins, insulating devices, and other suitable materials at the site to enclose or protect all portions of the concrete requiring protection. Materials shall be installed as close as possible before placing the concrete, and it shall be installed as rapidly as possible to keep exposure to cold weather to a minimum. Where heating is required, the spaces to be heated shall be completely enclosed and the temperature kept at required levels by the use of heaters approved by the Engineer.
4. The Contractor shall provide a sufficient number of maximum/minimum recording thermometers to record temperatures in each concrete placement undergoing cold weather protection.
5. The curing period for all structure concrete requiring cold weather protection shall conform to the cold weather protection period except when the normal curing period is longer.

3.15 UNDERPINNING OLD FOUNDATIONS

If underpinning is required, the Contractor shall perform the required Work as directed by the Engineer. The operation shall consist of the restoring or lowering of the old foundations with concrete. The concrete shall be Mix No. 6. Excavation and the underpinning operations shall be done in part section, so as not to remove more than 10 percent of the supporting area under the old foundation at one time. The concrete shall have a maximum slump of one and one- half inches (1-1/2″). When directed by the Engineer, underpinning shall be installed by hand, pneumatic, or pumping processes. The usual curing and cold weather requirements will be deleted for the underpinning with other provisions for curing and protection improvised on the job as may be directed.

3.16 LOADS ON CONCRETE STRUCTURES

A. The erection of structural steel or concrete superstructures on concrete substructures shall not start until the Contractor has completed curing, removed forms, and substructure concrete has reached a minimum compressive strength of three thousand (3000) psi.

B. Loads shall not be applied to any new portion of bridge deck or box culvert built to grade until the final section of that unit of the deck has completed its specified curing period. Vehicles, including the Contractor's, and heavy equipment are not permitted on any new portion of bridge deck or box culvert built to grade until the concrete cylinder breaks for the final section of that unit of the deck has attained a minimum compressive strength of forty-five hundred (4500) psi. However, loads such as stored materials, lightweight equipment,

concrete safety parapets, sidewalks, median curbs, etc., may be placed upon the concrete slab via cranes or other lifting devices when the concrete in the final section of that unit of the deck has attained a minimum compressive strength of three thousand (3000) psi.

C. Backfill shall not be placed on any new portion of box culverts not built to grade until the final section of that unit of the slab has completed its specified curing period and the concrete in that section has attained a minimum compressive strength of three thousand (3000) psi.

3.17 PREVENTION AND REMOVAL OF STAINS ON CONCRETE

The Contractor shall prevent rust from structural steel, staining by asphalt materials or any other substance from discoloring any portion of the concrete. The Contractor shall use construction procedures that prevent staining of any of the concrete. Where unpainted structural steel has been specified, the Contractor shall protect the pier caps, columns and abutments with a wrapping of reinforced polyethylene or similar material which shall be left in place to prevent staining until after the structure has been completed. If any portion of the concrete is stained, the stains shall be removed and concrete restored to its original color without damage to the concrete. The Work shall be done as directed by the Engineer at no additional cost to the City. Chemical solvents shall not be used to remove stains unless approved by the Engineer.

3.18 SAFETY HAZARDS

A. The Contractor shall be responsible for gas detection in and ventilation of confined spaces.

B. When procedures require workers to enter confined spaces such as steel or concrete box section type superstructures, particularly when the interior is closed off at both ends, the Contractor shall be cognizant of the potential health hazards.

C. The Contractor shall adhere to all applicable Maryland Occupational, Safety and Health (MOSH) regulations. The Contractor shall have approved detecting devices available and shall conduct tests for oxygen content and presence of gases, such as combustible gas, carbon dioxide, methane, carbon monoxide, and hydrogen sulfide whenever any fabrication, erection or inspection operations are to be performed within the confined spaces. The Contractor shall apply mechanical ventilation continuously to the confined space during occupancy to maintain the proper oxygen content and shall conduct air tests periodically during the occupancy.

D. Defective Work exposed upon removal of the forms shall be entirely removed or repaired within twenty-four (24) hours, as directed by the Engineer.

1. Edges of material remaining in place shall be cut perpendicular to the finished surface to the full depth of the material removed, but not less than 1 inch. If the removal of defective concrete affects the structural requirements, the member also shall be removed and replaced as directed by the Engineer.
2. Defective areas shall be cleaned.
3. Defective areas shall be coated with an epoxy bonding compound.
4. Defective areas shall be patched with concrete mortar or epoxy. The color, contour, and texture of surrounding concrete shall be matched as close as possible.

PART 4 MEASUREMENT AND PAYMENT

A. Portland cement concrete structures will be measured and paid for as specified. The payment will be full compensation for all forms and form removal, reinforcement steel, curing and misting, scuppers, grooving, mechanical and electrical Work, all cost incidental to the conducting of tests for oxygen content and presence of gases and applying mechanical ventilation to confined spaces, year built markings, and all material, labor, equipment (including safety equipment), tools and incidentals necessary to complete the Work.

B. The construction of drainage and weep holes, any pipe necessary, expansion material, flashing, damp proofing, membrane waterproofing, epoxy bonding compound, joints and their placement will not be measured but the cost will be incidental to the concrete item. No deduction in concrete quantities will be made for pipes or conduits having diameters less than 8 inches, reinforcement steel, anchors, or any other appurtenances.

C. Portland cement concrete for footing concrete, subfoundation concrete and tremie concrete will be measured and paid for at the Contract Unit Price per cubic yard.

D. Portland cement concrete for substructure concrete for bridges, superstructure concrete for bridges, and reinforced concrete box culverts will not be measured but will be paid for at the Contract lump sum price. The cost for epoxy protective coated reinforcement steel shall be excluded from the Contract lump sum price for superstructure concrete for bridges. When a bridge deck rehabilitation project, other than bridge widenings, requires modification to the backwalls and wing walls and there is no substructure concrete item, the concrete will be incidental to the Superstructure Concrete item.

E. Wing walls and footings for reinforced concrete box culverts will not be measured but the cost will be incidental to the reinforced concrete box culvert item.

F. Parapets (including end posts) on bridges, wing walls, reinforced concrete box culverts and retaining walls, or concrete median barriers on bridges and top slabs of reinforced concrete box culverts will not be measured but will be paid for at the Contract lump sum price for the pertinent concrete parapet or concrete median barrier items.

G. Parapet and end post modifications on bridges, wing walls, reinforced concrete box culverts and retaining walls, or concrete median barriers on bridges and top slabs of reinforced concrete box culverts will not be measured but will be paid for at the Contract lump sum price for the pertinent parapet modification item. The payment will also include saw cutting, removal of portions of the existing parapet or end post, drilling, and grouting.

H. Floodlighting will be measured and paid for at the Contract Unit Price per each night used, including fuel, backup generator, setup, relocation, and removal.

I. Linseed oil protective coating will be measured and paid for at the Contract Unit Price per square yard for the pertinent linseed oil protective coating item.

J. Temporary supports or piling will not be measured but the cost will be incidental to the formwork.

K. Retaining walls will be measured and paid for as specified in 32 32 13, (Cast-in-Place Concrete Retaining Walls).

03 30 43 PRODUCTION PLANTS

PART 1 GENERAL

1.1 DESCRIPTION

These Specifications are applicable to all batching and proportioning plants.

1.2 APPROVAL

The plant from which the Contractor proposes to obtain material shall be approved by the Engineer before starting deliveries.

1.3 LEAD TIME

The Contractor shall notify the Engineer at least two (2) working days prior to the start of operations. The Engineer or its representative shall be kept informed of plant operational procedures and notified when a change is planned. Inspectors shall have safe access to all areas of the plant for the performance of their duties. All equipment, tools, machinery, and parts of the plant shall be maintained in a satisfactory working condition at all times.

1.4 STORAGE

The storage and handling of aggregates in stockpiles and bins shall be done in a manner that will prevent segregation, intermingling, and contamination by foreign material or equipment. Bins discharging to feeder systems shall be equipped with accessible calibrated devices to vary the quantity of material being fed.

1.5 MEASURING DEVICES

A. Measuring devices shall conform to the current edition of the National Institute of Standards and Technology Handbook 44, except as modified by the following Table A. The producer shall be responsible for providing all personnel and equipment for calibrating measuring devices.

B. Before any proportioning plant starts operation, and at least once each year thereafter, all measuring devices, meters, dispensers, test weights, and other measuring devices shall be inspected, tested, and certified to be in proper operating condition by competent testing agencies approved by the Engineer. During the period of operation, all measuring devices, meters, dispensers, and other measuring devices shall be tested monthly and certified for accuracy and operating condition by the producer or an approved testing agency. Any weighing device by which materials are sold by weight, as a basis of payment shall be tested monthly and certified by an approved testing agency. The Engineer shall be notified at least two (2) working days in advance of monthly scale inspections. The certifications shall state capacities, minimum graduations, loads applied, degree of accuracy, and magnitude.

C. Balance and zero conditions of scales shall be checked daily, and at any other time requested by the Engineer or its representative. The Engineer may, at any time, direct that any measuring device be tested by the producer or an outside agency if there is any doubt about the accuracy of the measuring device. Certificates of inspection shall be

posted in a prominent place in the plant, and a copy shall be promptly submitted to the Engineer.

D. Production plant tolerances shall conform to the following Table A:

TABLE A

MATERIAL	*MAINTENANCE TOLERANCE	UNIT OF MEASURE
Aggregate	0.2%	Weight
Portland Cement or Blended Hydraulic Cement of Ground Iron Blast Furnace Slag or Fly Ash	0.2%	Weight
Asphalt	0.2%	Weight or Volume
Water	1.5%	Weight or Volume
Additives	0.5%	Weight or Volume

* Maintenance tolerance shall be the specified percent of the total capacity of the scale or the smallest scale graduation, whichever is greater.

E. If during the monthly check, the measuring devices are found to deviate from the allowable tolerance, they shall be suspended from use until recalibrated to the Specification requirements. A price adjustment will apply to materials sold and accepted by weight that are supplied during the measuring device malfunction period when the malfunction resulted in an overpayment. The measuring device malfunction period is defined as the elapsed time between the two successive monthly checks.

1.6 SAMPLING EQUIPMENT

The producer shall provide all personnel and equipment for obtaining samples from the last practical point prior to combination with other ingredients or introduction into the mixer. Sampling of liquid binder from HMA plants shall be from a tap located at the last practical, safe point, between the binder control unit and the plant (refer to M 156 and D 140). Sampling shall conform to Tables 1 and 2 of the Maryland Standard Methods of Tests (MSMT) Manual. The sampling equipment shall have a minimum capacity of thirty (30) lb and shall be positioned in a manner that will provide an accurate representation of the material being furnished. When the size of the sample is too large to be transported, approved sample splitting devices shall be available at the point of sampling that will split the sample to no more than twice the proper testing size.

1.7 QUALITY CONTROL LABORATORY

The producer shall provide at proportioning or batching plants an on-site City approved laboratory suitable for conducting the various tests required. An off-site laboratory shall require approval of the Engineer. Continued approval of the laboratory and the testing personnel will be subject to periodic inspection by the City. Any deficiencies shall be corrected to the satisfaction of the Engineer or the approval will be withdrawn.

PART 2 PRODUCTS

Not Applicable.

PART 3 EXECUTION

3.1 HOT MIX ASPHALT (HMA) PLANTS

A. All plants shall conform to M 156, and be equipped with automatic batching and recording of batching, except as modified in 32 12 16.13, (Plant Mix Asphalt Pavement) and the following:

1. Dryer. The fuel used for drying aggregates shall be compatible with the plant manufacturer's recommendations.
2. Hot Aggregate Bins. Existing plants shall be equipped with alarms. New plants shall conform to M 156.
3. Mixer Unit for Batch Method. Minimum dry and wet mixing times shall be five (5) seconds and fifteen (15) seconds, respectively.
4. Truck scale weighing shall conform to the National Institute for Standards and Technology (NIST), except as follows:

    a. A written plant summary shall be kept by the producer showing the Contract number, truck identification (I.D.) number, type material being produced, the number of truckloads, and the total tons of mix.
    b. The producer shall supply a delivery ticket with the I.D. number, Contract number, date, truck I.D. number, time loaded, gross and tare weights, and net weight of the mix for each load. When requested by the Engineer, the temperature of the mix shall also be shown on the delivery ticket.

5. Automatic Weighing and Printout. The producer shall use an approved plant automatic weighing and printing system. A printed delivery ticket for each load shall be provided with the cumulative total weighed into the truck, Contract number, time loaded, I.D. of the type of mix, and net weight of mix. When requested by the Engineer, the temperature of the mix shall also be shown on the delivery ticket. The temperature may be handwritten on the delivery ticket.
6. Hauling Units. The mixture shall be transported to the work site in units previously cleaned of all foreign material and the contents of each load completely covered with suitable material of sufficient size to protect it from the weather. Each unit shall have convenient access from ground level to insert thermometers to determine mix temperature.
7. The inside surface of all hauling units shall be treated with an approved release agent that will not contaminate or alter the characteristics of the mixture. Petroleum derivatives shall not be used. Approval will be based on results from tests performed in conformance with MSMT 414.
8. Drum mixer plants shall be calibrated in conformance with MSMT 453 and approved by the Engineer. A monitoring station for the purpose of controlling the entire operation shall be provided. If any part of this control system fails, an alternative control system approved by the Engineer may be used for a maximum of two (2) working days.
9. The producer shall determine the moisture content of all aggregates in conformance with MSMT 251.

B. Certified Hot Mix Asphalt (HMA) Plant

1. The producer shall be responsible for quality control of plant operations to ensure that the material conforms to Specifications. The quality control process will be subject to unannounced periodic inspection by representatives of the Engineer when City projects are in progress. The plant's certified technician shall fully participate in the inspections.
2. Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specifications. The City will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specifications; however, final acceptance will be determined by the City.

3. Responsibilities of the HMA Producer.

    a. Notification. The producer shall notify the Engineer one (1) working day prior to producing materials for City projects.
    b. Quality Control. The minimum sampling and testing frequencies and criteria necessary for quality control of the HMA is the responsibility of the producer. The producer shall develop and use a quality control plan acceptable to the Engineer, which addresses all elements necessary for quality control in the plant.
    c. The producer shall conduct the minimum sampling and testing as specified in MSMT 730, Table 3. The producer shall perform any additional sampling and testing when directed by the Engineer. The producer shall offer to the Engineer the opportunity to witness all sampling and testing.
    d. Reports. The producer's test results shall be furnished to the Engineer on documents approved by the City.

4. Responsibilities of the City.

    a. Verification Testing. The City will provide acceptance by conducting verification sampling and testing and independent assurance sampling and testing on quality control sampling and testing as follows:
    b. The Engineer will conduct acceptance verification by directing the producer to obtain independent verification samples at any time and location during production or placement, by monitoring the required production control charts and the required quality control plan. Verification sampling and testing of asphalt mixtures will be in conformance with MSMT 730, Table 3. The Engineer's verification testing will be separate from the producer's testing.
    c. The Engineer may take or request the producer to obtain test samples at any time to confirm the effectiveness of the activities of the plant and field quality control technicians. The Engineer may direct that production be suspended if proper sampling and testing procedures are not followed or if the producer is not following the approved quality control plan.
    d. Acceptance will be given when the Engineer's verification test results conform to Specifications and are within two (2) standard deviations (2SD) of the quality control test results from the last verification visit. Also, all mixes produced since the last verification visit will be evaluated as

specified in 32 12 16.13, (Plant Mix Asphalt Pavement) to determine the pay factor based on the deviation from target values.

e. Re-certification of HMA Plant. Documentation of corrective action shall be submitted to the Engineer by a professional engineer registered in the State of Maryland. When this documentation is approved by the Engineer, a comprehensive inspection will be conducted to re-certify the HMA plant.

f. Independent Assurance Audits. The City will evaluate the proficiency and equipment of QC/QA Technicians through audits performed on a random basis. The technician being audited shall cooperate with the auditor in the evaluation of their proficiency and equipment.

g. Technician Certification. Technician certification will be in conformance with MSMT 731.

3.2 PORTLAND CEMENT CONCRETE PLANTS

A. Portland cement concrete plants shall conform to M 157 except as modified herein, including the applicable requirements of this Specification.

B. Storage of Aggregate. Coarse and fine aggregate for use in portland cement concrete shall be maintained at uniform moisture content in excess of its saturated surface dry condition. Water added for this purpose shall conform to 03 30 00, (Portland Cement Concrete Structures).

C. Temperature of Water and Cement. The plant shall be equipped with methods of heating or cooling the mix as approved by the Engineer. The temperature of the cementitious materials and the mixing water at the time they are to be used in the mix shall not exceed one-hundred seventy degrees (170°) F.

D. Load Tickets. The producer shall issue a completed form in duplicate for each load. Distribution shall be made as specified in paragraph 3.2, F. The producer's copy shall be readily available for inspection upon request by the Engineer or its representative. Computer generated printouts may be used in lieu of the City's load ticket when approved by the Engineer.

E. Mixers and Agitators. The requirements for mixers and agitators and for mixing and delivery of ready mixed concrete shall conform to M 157 with the following exceptions:

1. During transit, drums shall be operated at agitating speed only. Mixing during transit is prohibited.

a. At least eighty-five percent (85%) of design water requirement shall be added at the plant through the certified plant water meter.

b. Water for slump adjustment may be added at the plant through the City approved truck water system under the supervision of the certified concrete technician, provided the maximum specified water/cement ratio is not exceeded.

c. A maximum of three (3) gallons of water per cubic yard of concrete may be added at the job site, provided the maximum specified water/cement ratio is not exceeded.

d. No water shall be added after partial discharge of the load.

2. No mixer or agitator containing wash water in the drum shall be loaded.
3. When the concrete is specified or permitted to be made by volumetric batching and continuous mixing, the batching and mixing unit shall conform to C 685. Calibration shall conform to MSMT 558.
4. Where no mixer performance tests are made for stationary mixers, the minimum mixing time shall be seventy-five (75) seconds.

F. Certified Concrete Plant

1. The producer shall be responsible for quality control of plant operations to ensure that the material conforms to Specification requirements. The quality control process will be subject to unannounced periodic inspection by representatives of the Engineer. Full participation in the inspection by the plant's certified technician will be required.
2. Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specification requirements. The City will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specification requirements. However, final acceptance will be determined by the City.
3. Responsibilities of the Concrete Producer.

    a. The producer shall notify the Engineer one (1) working day prior to producing materials for City projects.
    b. Quality Control. All producers supplying concrete shall have the certified concrete plant technician present while concrete is being batched and delivered to the project. This technician shall supervise concrete production.

        1) The producer shall develop and use a quality control plan acceptable to the Engineer that addresses all elements necessary for quality control in the plants.
        2) Control tests shall be performed by the certified concrete plant technician. This technician shall perform moisture tests, adjust proportions of aggregate for free moisture, complete and sign batch or approved delivery tickets, and ensure quality control of the batching operations.
        3) Technician certification will be awarded upon satisfactory completion of examinations in conformance with MSMT 560.
        4) The producer shall supply all necessary test equipment.
        5) Sample frequency shall conform to the MSMT frequency guide, Table 1.

    c. Reports. The following reports will be processed by the producer:

        1) Daily form stating that the material was sampled and tested in conformance with the City's sampling and testing guidelines and complies with the applicable Specifications and distribution to producer's file and City.
        2) Form for each load. Distribution to project and producer's file.

3) Forms for all concrete materials sampled at the plant in conformance with MSMT frequency guide Table 1.
4) Daily test worksheet – for all tests performed at the plant.

4. Responsibilities of the City.

a. Comprehensive Inspection.
b. Acceptance Inspection and Testing.

1) If deficiencies are found during a City inspection, the producer will be notified immediately to correct the deficiencies to the satisfaction of the Engineer. Production will be suspended for critical deficiencies.
2) If consecutive inspections reveal identical deficiencies, or if additional deficiencies are found, the producer will be notified that a re-inspection will be held in two (2) production days. All deficiencies shall be corrected by the re-inspection date.
3) If re-inspection fails, the Engineer will assign an Inspector to monitor plant operations for a maximum of five (5) City production days. If at the end of this period the quality control process is not satisfactory, plant approval will be rescinded and the plant must be re-certified before City production will be continued.
4) Re-certification of Concrete Plant. Documentation of corrective action shall be submitted to the Engineer by a professional engineer registered in the State of Maryland. When this documentation is approved by the Engineer, a comprehensive inspection will be conducted to re-certify the concrete plant.

c. Independent Assurance Audits. The City will evaluate the proficiency and equipment of QC/QA technicians through audits performed on a random basis. The technician being audited shall cooperate with the auditor in the evaluation of their proficiency and equipment.
d. Technician Certification in conformance with MSMT 560.

3.3 BASE COURSE PLANTS

A. Nonstabilized. Base course plants producing graded aggregate base material without a stabilizing agent shall conform to paragraph 3.3, C, and the following:

1. The material is produced in a processing plant using an approved aggregate source.
2. The quality control plan shall be submitted to and approved by the Engineer prior to production.
3. The production shall conform to the gradation requirements of the approved job mix formula.
4. The required moisture content shall be maintained prior to shipment.
5. Stockpiles shall be maintained to prevent segregation.
6. Frozen aggregates shall not be used.
7. Mixed material shall be handled and transported in a manner that will minimize segregation and the loss of moisture. All loads shall be covered in conformance with State laws unless hauling is off road and approved by the Engineer.

B. Stabilized: Stabilized base course plants shall conform to PART 1 and PART 3 of this specification and the following:

1. Mechanical mixers shall be used, as approved by the Engineer. All plants shall be equipped with automatic cutoff devices interlocked so the plant will stop operating if delivery of any component of the mix fails.
2. The amount of stabilization shall be determined in conformance with MSMT 254.
3. The charge in a batch mixer, or rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all materials.
4. Mixed materials shall be handled and transported in a manner that will minimize segregation and loss of moisture or volatiles. All loads shall be covered in conformance with State laws unless hauling is off road and approved by the Engineer.
5. When cement is used as a stabilizing agent, the amount of water added at the plant shall be controlled to obtain a uniform mixture that conforms to the required density.
6. When emulsified asphalt is used as a stabilizing agent, all aggregate shall contain moisture in excess of the saturated surface dry condition at time of mixing.

C. Certification of Base Course Plants

1. The quality control and condition of all materials used in base courses, as well as all necessary adjustments required in using the materials, shall be the responsibility of the base course producer. The quality assurance process will be subject to unannounced periodic inspection by representatives of the Engineer when City projects are in progress. The plant's certified technician shall participate in the inspection.
2. Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether the plant equipment and personnel conform to all applicable Specification requirements. After the initial inspection the plant shall conform to section 3.1, B, 2. The City will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specification requirements. However, final acceptance will be determined by the City.
3. Responsibilities of the Base Course Producer.

    a. The producer shall notify the Engineer one (1) working day prior to producing materials for City projects.
    b. Quality Control. The producer shall be responsible for quality control of plant operations to ensure that the material conforms to Specification requirements. All producers supplying base courses shall have a certified base course plant technician present while base course material is being plant mixed and delivered to the project. This technician shall supervise base course production.

        1) Control tests shall be performed by a certified base course plant technician. This technician shall obtain samples and test in conformance with MSMT frequency guide Table 1 and 2.
        2) Technician certification will be awarded upon satisfactory completion of an examination in conformance with MSMT 562. The certification shall be as follows:

a) Applications for certification shall be obtained a minimum of thirty (30) days prior to producing material for the City.
b) The producer will schedule an examination based on AASHTO and MSMT procedures and knowledge of the City's base course plant reports and documentation.
c) Upon satisfactory completion of the examination, a certificate will be issued.

3) The producer shall supply all necessary test equipment. In addition, the producer shall provide on-site facilities suitable for conducting the required tests. Off-site test facilities shall require approval of the Engineer.

c. Reports. The following reports shall be processed by the producer:

1) Daily form stating that the material was sampled and tested in conformance with the City's sampling and testing guidelines and conforms to the applicable Specifications. Distribution to City and producer's file.
2) Form for all additives introduced at the plant, frequency in conformance with Table 2. Distribution to the City and producer's file.
3) Daily Plant Certification Form showing that a technician was on duty at the plant. Distribution to project and producer's file.
4) Daily Test Worksheet, for all tests performed at the plant.
5) Daily base course plant checklist. Distribution to producer's file.

4. Responsibilities of the City.

a. Comprehensive Inspection.
b. Acceptance Inspection and Testing.

1) If deficiencies are found, as defined in the base course plant checklist during an acceptance inspection, the producer will be notified immediately and operations shall be suspended if corrections are not made to the satisfaction of the Engineer.
2) If on consecutive inspections identical deficiencies are found, the producer will be notified that a re-inspection will be held in two (2) City production days. All deficiencies shall be corrected by the re-inspection date. The Engineer will determine whether plant certification will be revoked.

c. Independent Assurance Audits. The City will evaluate the proficiency and equipment of QC/QA technicians through audits performed on a random basis. The technician being audited shall cooperate with the auditor in the evaluation of their proficiency and equipment.
d. Recertification of Aggregate Base Course Plant. Documentation of corrective action shall be submitted by a professional engineer registered in the State of Maryland. When this documentation is approved, a comprehensive inspection will be conducted to re-certify the base course plant.
e. Technician certification in conformance with MSMT 562.

3.4 CERTIFIED PRECAST CONCRETE PLANTS

A. The producer shall be responsible for quality control plant operations to ensure that the material conforms to Specifications. The quality control process will be subject to unannounced periodic inspection by representatives of the Engineer. The plant's certified technician shall fully participate in the inspections.

1. Initial Inspection. Any plant initially setting up and starting production will be subject to a comprehensive inspection to determine whether plant equipment and personnel conform to all applicable Specifications and that suitable testing facilities will be available. The City will accept certification by a professional engineer registered in the State of Maryland that the plant facilities conform to all applicable Specifications; however, final acceptance will be determined by the City.

B. Responsibilities of the Precast Concrete Producer.

1. Notification. The producer shall notify the Engineer at least two (2) working days prior to producing materials for City projects.
2. Quality Control Procedures. Quality control procedures shall include the following:

    a. Sampling and testing in conformance with Tables 1, 2, and 3 of the MSMT sample frequency guide.
    b. The method of inspecting reinforcement steel placement and forms prior to pouring concrete.
    c. The method of curing the concrete.
    d. The method of maintaining accurate quality control records.
    e. Samples of documents approved by the Engineer.
    f. Patching procedures.
    g. Methods of preparing the concrete units for shipment.
    h. A method of identifying each piece as tested and approved by quality control.

3. Quality Control Plan. The producer shall submit a quality control plan prior to the start of production. The plan shall indicate the following:

    a. All precast concrete products shall conform to the Standards or approved Working Drawings. All materials shall be from a City approved source and shall conform to all applicable Specifications.
    b. The plan shall indicate how the producer intends to handle all of its materials. Certification of materials shall be as specified in the MSMT sample frequency guide.
    c. The names, qualifications, and responsibilities of a quality control manager and a quality control technician.

4. Quality Control Technician. The quality control technician may be approved if certified from at least one of the following:

    a. The National Precast Concrete Association.
    b. The Precast/Prestressed Concrete Institute Plant Certification Program. American Concrete Institute.
    c. Taking the Maryland Certified Concrete Technician course and passing the test.

5. Test Equipment and Facilities. The producer shall supply all necessary test equipment. In addition, the producer shall provide City approved facilities suitable for conducting the various tests required. Off-site test facilities shall require approval of the Engineer.

C. Responsibilities of the City.

1. Comprehensive Inspection.
2. Verification Testing.

a. Verification of certification will be performed at the discretion of the City a minimum of once per year.
b. The City reserves the right to discontinue acceptance of precast units if its verification indicates that materials or test procedures do not conform to the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

Not applicable.

03 30 53.01 MISCELLANEOUS STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing miscellaneous cast-in-place concrete or masonry structures, installing precast concrete or polyethylene (PE) structures, and cleaning existing inlets as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mortar sand shall conform to 32 11 23.10, Part 2.1, (Aggregate Base Course).
Curing materials shall conform to 03 30 00, Part 2.1, A, (Portland Cement Concrete Structures).

B. Concrete Mix No. 2, No. 3 or No. 6: shall conform to 03 30 00, Part 2.1, G, (Portland Cement Concrete Structures).

C. Grout shall conform to 03 30 00, Part 2.1, G, (Portland Cement Concrete Structures).

D. Brick shall conform to M 91, Grade MS.

E. PE pipe shall conform to 33 41 00, Part 2.1, (Storm Utility Drainage Piping).

F. PVC shall conform to 33 11 13, (Public Water Utility Distribution Piping).

G. Reinforcement steel shall conform to 32 13 13.33, Part 2.1, B, (Plain and Reinforced Portland Cement Concrete Pavement).

H. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

I. Castings for Frames, Covers, Gratings and Steps: Iron castings shall conform to A 48, Class 30B.

J. Polyethylene (PE) Manholes shall conform to the following:

1. PE manholes shall conform to D 1248, Type III, Class C, Category 3, Grade P34. Working Drawings shall be submitted to the Engineer prior to fabrication.
2. Compressive strength shall be determined in conformance with D 2412, modified pipe stiffness test. Pipe stiffness shall be a minimum of twelve (12) psi at five percent (5%) deflection, including joints. Axial compressive strength shall be a minimum of ten thousand (10000) lb at less than three percent (3%) deflection.
3. PE manholes for storm drains shall be manufactured with an invert bowl which will not interrupt flow. Manholes for sanitary sewers shall have a factory molded invert for channeled flow.
4. The manufacturer shall furnish certification. This certification shall be a document, which verifies that the material and Work comply with the applicable Specifications and include the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification shall accompany each shipment of PE manholes and shall show actual test results, the quantity of manhole sections, and date of manufacture. Manholes shall be marked with the manufacturer's name and trademark.

K. Zinc coating shall conform to A 153.

L. Stone shall conform to M 43 Size No. 57.

M. Precast Concrete End walls, inlets, and manholes shall conform to M 199.

PART 3 EXECUTION

3.1 GENERAL

Refer to 03 30 00 (Cast-in-Place Concrete) for portland cement concrete, 04 21 13, (Brick Masonry) for brick masonry, and 31 23 16.16, Part 3.2, (Structure Excavation) for excavated material.

3.2 CONSTRUCTION SEQUENCE

A. Underground drainage structures shall be completed before roadway surfacing is placed. Manholes, catch basins and inlets shall not be completed to final grade until the grading has been finished and all necessary arrangements have been made to ensure suitable connections and tie-ins at proper grade and alignment with pavements, gutters and curbs.

B. PE manholes shall be installed as recommended by the manufacturer.

3.3 CASTINGS

Frames for grates and covers for inlets and manholes, except PE manholes, shall be set in full beds of mortar and rigidly secured in place to proper grade and alignment as specified in the Contract Documents.

3.4 PIPE CONNECTIONS

Inlet and outlet pipes at drainage structures shall be set or cut flush with the inside faces of the structures and shall extend a sufficient distance beyond the outside faces of these walls to provide ample room for making proper connections. The joint around the pipe in the structure wall shall be completely and neatly closed with mortar or other specified materials.

3.5 INVERTS

Drainage structures containing two (2) or more pipes shall have channeled inverts conforming to the Contract Documents.

3.6 DRAINAGE STRUCTURES

Inlets and manholes shall contain two (2), eight inch (8″) minimum diameter blockouts for underdrains. The drainage structures shall be backfilled with No. 57 aggregate for a width of one and one-half feet (1-1/2′) outside of the structure and extend from the bottom of the structure to the subgrade.

3.7 PRECAST DRAINAGE STRUCTURES

A. Working Drawings for structures not detailed in the Contract Documents shall be submitted to the Engineer for approval prior to fabrication.

B. Certification. Certification from the manufacturer for each shipment of precast units is required. A copy of the certification shall be delivered to the Engineer and the Contractor with each shipment. One (1) copy shall remain at the plant. The certification shall contain the name and address of the manufacturer, the type of structure, the identification number, the date of manufacture, the date of shipment, a statement indicating conformance with the Specifications, and the signature of the quality control manager. Noted on the unit shall be the station number and designation, the identification number, the name or trademark of the manufacturer, the date manufactured, and a stamp indicating conformance with the Specifications.

C. No precast unit shall be shipped unless it has been tested and is shown to be in full compliance with the Contract Documents.

D. The placement and consolidation of the required bedding under the unit shall be a minimum six inch (6″) of No. 57 aggregate unless otherwise directed by the Engineer.

3.8 CLEAN EXISTING INLETS

The existing inlets shall be cleaned and the material disposed of as directed by the Engineer. If the existing grate has to be removed, it shall be replaced and anchored to the satisfaction of the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, concrete, masonry, special or precast units, reinforcement, ladder rungs, drip stones, No. 57 aggregate, underdrain stubs, frames, grates and covers, grade and slope adjustments, backfill and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Standard inlets and manholes specified in the Contract Documents will be measured and paid for at the Contract Unit Price per each. When a structure exceeds the standard minimum depth specified in the Contract Documents, an additional payment will be made for the excess depth at the Contract Unit Price per linear foot for the pertinent vertical depth item.

C. Standard end walls, headwalls, end sections and special structures will be measured and paid for at the Contract Unit Price per each.

D. Nonstandard end walls and other miscellaneous structures such as steps, spring boxes, and junction boxes, constructed using brick masonry or concrete will be measured and paid for at the Contract Unit Price per cubic yard unless otherwise specified in the Contract Documents.

E. No separate or additional measurement will be made for any precast concrete units, metal or castings used in the construction of any of the items noted above.

F. Cleaning existing inlets will be measured and paid for at the Contract Unit Price per each, regardless of type, size, or depth of the inlet.

G. When an existing drainage structure is to be removed and replaced with a new drainage structure in the same location, the cost to remove the existing drainage structure and a section of the existing pipe will be incidental to the cost of the new drainage structure.

03 31 00 STRUCTURAL CONCRETE

03 31 16 LIGHTWEIGHT SUPERSTRUCTURE CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing the lightweight concrete portions of the structure as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials shall conform to the 03 30 00, Part 2, (Portland Cement Concrete Structures) except as modified herein.

B. Control testing for compression test and unit weight of cured concrete shall be two (2) companion cylinders for each one hundred (100) yd^3 or fraction thereof, as specified in M 195.

C. Lightweight concrete shall have a minimum compressive strength of forty-five hundred (4500) psi. It shall be composed of Type I portland cement, an approved air entraining admixture, Type A or D chemical admixture, water, lightweight coarse aggregate, fine aggregates and be proportioned as specified in 211.2 of the ACI's recommended practices for selection proportions for structural lightweight concrete. Fly ash or ground iron blast furnace slag may be substituted for portland cement as specified in the following:

1. Fly Ash. Fly ash shall conform to M 295, pozzolan Class C or F, except that the maximum permissible moisture content shall be one percent (1.0%), and when used in concrete Mix Nos. 3 and 6 the loss on ignition shall not exceed three percent (3%).
2. Ground Iron Blast Furnace Slag. Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.

D. Minimum cement content shall be seven hundred (700) lb/yd^3. The maximum average unit weight of the cured concrete shall be one-hundred eighteen (118) lb/ft^3. Air entrainment shall be determined by volumetric method as specified in T 196 and shall be 6 to 9 percent (entrapped plus entrained). Slump shall be three inches (3″) maximum when the absorption of the coarse aggregate is greater than ten percent (10%), but shall be two inches to five inches (2″ to 5″) when the absorption of the coarse aggregate does not exceed 10 percent. Water added to the mix using saturated aggregates shall not exceed a water/cement ratio of forty-five hundredths (0.45). Net water including the absorbed water shall not exceed a water/cement ratio of seventy-five hundredths (0.75).

PART 3 EXECUTION

3.1 GENERAL

A. Construction shall conform to the 03 30 00, Part 3, (Portland Cement Concrete Structures) and the following:

B. Handling of lightweight aggregates shall be arranged to provide a thorough sprinkling of the aggregates during the stockpiling to produce damp aggregate. Sprinkling shall be done to obtain uniform distribution of moisture. Aggregates shall then be allowed to drain as long as necessary to produce uniform moisture content and the moisture content shall be maintained as much as practical until the aggregate is used. The admixtures shall be added to the mix as specified in the manufacturer's recommendations.

3.2 EXISTING STRUCTURES

Existing bridge decks shall be removed as specified in the 02 41 16.33, Part 3, (Bridge Demolition). The Contractor is cautioned that the deck replacement material may be lighter than the existing deck and the deflection caused by the lighter material will be less than the material removed. The Contractor shall compute modified rebound figures to be used in lieu of dead load deflections to establish grade controls to produce finished tops of concrete bridge decks that will be true to the planned line and grade.

PART 4 MEASUREMENT AND PAYMENT

A. Lightweight concrete structures will be measured and paid for as specified. The payment will be full compensation for all forms and form removal, reinforcement steel, curing and

misting, scuppers, mechanical and electrical Work, all cost incidental to the conducting of tests for oxygen content and presence of gases and applying mechanical ventilation to confined spaces, year built markings and for all material, labor, equipment (including safety equipment), tools, and incidentals necessary to complete the Work.

B. The construction of drainage and weep holes, any pipe necessary, expansion material, flashing, damp proofing, membrane waterproofing, epoxy bonding compound, joints and their placement will not be paid for but the cost will be incidental to the lightweight concrete item. No deduction in lightweight concrete quantities will be made for pipes or conduits having diameters less than eight inches (8″), reinforcement steel, anchors, or any other appurtenances.

C. Lightweight Superstructure Concrete will not be measured but will be paid for at the Contract lump sum price unless otherwise specified in the Contract Documents.

D. Lightweight concrete parapets and median barriers will not be measured but will be paid for at the Contract lump sum price for the pertinent Lightweight Concrete Parapet or Lightweight Concrete Median Barrier items.

E. Floodlighting will be measured and paid for as specified in the 03 30 00, Part 4, (Portland Cement Concrete Structures).

F. Linseed Oil Protective Coating will be measured and paid for as specified in the 03 30 00, Part 4, (Portland Cement Concrete Structures).

03 31 27 LATEX MODIFIED CONCRETE OVERLAY FOR BRIDGE DECKS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of removing a specified amount of the existing bridge deck mechanically or through hydromilling, removal of additional areas of deteriorated concrete, cleaning all surface areas to be overlaid, replacing deteriorated reinforcement steel and placing latex modified concrete (LMC), as specified in the Contract Documents.

1.2 RESTRICTIONS

Placement of LMC on bridge decks is prohibited between November 30 and April 30. The Contractor shall not scarify any bridge deck that will not be overlaid and cured prior to this restriction.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fine Aggregate shall conform to the 31 62 13.21, Part 2, (Protective Jackets for Piles).

B. Coarse Aggregate Size No. 7 shall conform to the following:

1. Grading requirements are outlined in the following Table A, physical properties are in Table B. Force drying may be used in the preparation of samples for grading tests conducted in the field. Steel slag may be used for chip seal surface treatment, but it shall not be used for any other aggregate.

C. Portland Cement Type I. Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 153 and T 131, respectively.

D. Concrete for Patching. The concrete mixes shall conform to Table C and the following:

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

MATERIAL	SIEVE SIZE				
	3/4"	1/2"	3/8"	No. 4	No. 8
COARSE AGGREGATE Size No.7 PORTLAND CEMENT CONCRETE	100	40–70	0–15	0–5	90–100

TABLE B – AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

MATERIAL TYPE I	SPECIFICATION	T 104	T 112	T 113	T 112 & T 113	T 11	T 113	D 4791 (a)	T 96
		SODIUM SULFATE SOUNDNESS	CLAY LUMPS & FRIABLE PARTICLES	CHERT LESS THAN 2.40 Sp Gr	SUM OF CLAY LUMPS, FRIABLE PARTICLES & CHERT	MATERIAL FINER THAN No. 200 SIEVE	COAL & LIGNITE	FLAT ELONGATED	LOS ANGELES ABRASION
		% max	% max	% max	% max	% max	% max	% max	% max
COARSE AGGREGATE — PCC (a)	M 80 CLASS A	12	2.0	3.0	3.0	1.0(b)	0.5	12	50

Note: (a) Coarse and fine aggregate for PCC shall be tested for alkali silica reactivity (ASR) as specified in MSMT 212.
Note: (b) 1.5 if material passing No. 200 sieve is dust of fracture, free of clay or shale.

TABLE C – CONCRETE CEMENT CONCRETE MIXTURES

Mix No.	28 Day Specified Compressive Strength psi	Standard Deviation psi	Critical Value psi	Min. Cement Factor lb/yd^3	Coarse Aggregate Size M 43	Max. Water/ Cement Ratio by wt	Slump Range in.	Total Air Content %	Concrete Temperature F
1	2500	375	2430	455	57, 67	0.55	2 – 5	5 – 8	70 ± 20
2	3000	450	3010	530	57, 67	0.50	2 – 5	5 – 8	70 ± 20
3	3500	525	3600	580	57, 67	0.50	2 – 5	5 – 8	70 ± 20
4	3500	525	3600	615	57, 67	0.55	4 – 8	N/A	70 ± 20
5	3500	525	3600	580	7	0.50	2 – 5	5 – 8	70 ± 20
6	4500	675	4770	615	57, 67	0.45	2 – 5	5 – 8	65 ± 15
7	4200	630	4420	580	57	0.50	1-1/2 - 3 2-1/2 max if slip-formed	5 – 8	70 ± 20
8	4000	600	4180	750	7	0.42	1 – 3	5 – 8	65 ± 15

Note 1: When concrete is exposed to water exceeding fifteen thousand (15000) ppm sodium chloride content, Type II cement shall be used. In lieu of Type II cement, a Type I cement may be used in combined form with an amount of up to fifty percent (50%) replacement with ground iron blast furnace slag or an amount of up to twenty-five percent (25%) replacement with Class F fly ash. The Contractor shall submit to the Engineer the proposed mix proportions and satisfactory test results in conformance with C 1012 showing a sulfate resistance expansion not exceeding one-tenth of one percent (0.10%) at one-hundred eighty (180) days.

Note 2: The temperature of Mix No. 6 when used for other than superstructure Work as defined in TC-1.02 shall be seventy degrees (70°) plus or minus twenty degrees (± 20°) F

Note 3: When synthetic fibers are used, the slump shall not exceed five inches (5″).

Note 4: Nonchloride Type C admixtures may be used when approved by the Engineer.

Note 5: If a high range water reducing admixture Type F or Type G is used, the slump requirement shall be four to eight inches (4″ to 8″).

Note 6: Type A or D admixture shall be added to bridge, box culvert, and retaining wall concrete.

1. Coarse and fine aggregate tested for alkali silica reactivity (ASR) as specified in MSMT 212 having an expansion up to one-tenth of one percent (0.10%) may be used without restriction. Those having an expansion greater than or equal to thirty-five-hundredths percent (0.35%) shall not be used. Aggregates having an expansion greater than one-tenth of one percent (0.10%) but less than thirty-five-hundredths percent (0.35%) shall be considered reactive and shall only be used when one of the following options as shown in the following Table D is employed:

TABLE D

OPTION	ALKALI CONTENT OF CEMENT % max	REPLACE CEMENT WITH		SPECIFICATION
		MATERIAL	% BY WEIGHT	
1	1.50	Class F Fly Ash	15 – 25	M 295
2	1.50	Ground Iron Blast Furnace Slag	25 – 50	M 302 Grade 100 or 120
3	1.50	Microsilica	5 – 7	C 1240
4	—	Blended Cement (a)	100	M 240
5	0.60 (b)	Low Alkali Cement	100	M 85

Note: (a) Pozzolan content of fifteen to twenty-five percent (15% to 25%) by weight of cement.

Note: (b) For mixes (Mix 6 Modified, Twelve (12) Hour Patch Mix) used for portland cement concrete pavement repairs; the maximum allowable percentage of alkalis in portland cement shall be seven-tenths percent (0.70%).

2. When reactive aggregate is used, the Contractor shall designate which option will be used to control the formation of the ASR gel. If an option other than option 5 in Table D above is chosen, the Contractor shall conduct tests as specified in MSMT 212 using the reactive aggregate and the proposed cementitious material. For approval, the expansion test results shall not be greater than one-tenth of one percent (0.10%). When more than one reactive aggregate is used in a concrete mix, each shall be tested individually and the maximum amount of pozzolan required to reduce the expansion of all the aggregates to less than or equal to one-tenth of one percent (0.10%) shall be used. The Contractor shall submit to the Engineer the aggregate source, test results, and the percent and type of replacement cement. The Engineer may withhold source approval pending verification testing.

E. Latex Modified Concrete: Portland cement concrete containing prequalified laboratory approved styrene butadiene latex emulsion is defined as Latex Modified Concrete (LMC).

1. Latex emulsion shall have a minimum of ninety percent (90%) of the nonvolatiles as styrene butadiene polymers. The latex emulsion shall conform to the following Table F. The material shall be stored in suitable containers and be protected from freezing and exposure to temperatures in excess of eighty degrees (85°) F.

2. Latex modified concrete shall be proportioned using volumetric mixing and designed as seen following Table F.

TABLE E – LATEX MODIFIED CONCRETE	
MATERIAL	**SPECIFICATION LIMITS**
Portland Cement, CWT/yd^3, min	6.6
Latex Emulsion/Cement Ratio	0.31 – 0.34
Water/Cement Ratio, max	0.22
Entrained Air, %	6.0 ± 3
Slump, in.	5 ± 1

3. The physical properties of LMC shall conform to the following Table G. The Contractor shall also furnish the necessary three inches by six inches (3″ X 6″) molds conforming to M 205 to be used for the fabrication of compressive strength cylinders.
4. Control and Acceptance Sampling.

   a. One (1) sample, two (2) quart minimum, of the styrene butadiene latex emulsion shall be submitted to the Engineer daily for each lot of material used in a day's production.

   b. A batch for LMC is defined as the capacity of the equipment being used on the project. Slump and air samples will be taken and tested before the placement of a batch is permitted. The slump shall be measured four to five (4 to 5) minutes after discharge from the mixer. The test material shall be deposited off the deck and not be disturbed during this waiting period. One (1) additional sample for slump and air will be taken randomly during the placement of each batch. For seven (7) day compressive strength, two (2) tests each per batch are required. A test is defined as consisting of two (2) companion cylinders. The samples for these tests will be taken at random while the placement is in progress.

TABLE F – REQUIREMENTS FOR CHEMICAL PROPERTIES OF LATEX EMULSION MATERIALS				
PROPERTY	**SPECIFICATIONS**		**QUALITY ASSURANCE TESTS**	
	LIMITS	TOLERANCE	PRE QUALIFICATION TESTS	CONTROL AND ACCEPTANCE
Color	White	—	X	X
pH	9.0 – 11.0	—	X	X
Weight, lb/gal	8.40 – 8.47	—	X	X
Solids Content, %	46 – 53	—	X	X
*Butadiene Content, % of polymer	30 – 40	—	—	—
Viscosity @ 10 rpm-cps	Match Original	± 20	X	X
*Surface Tension, dynes/cm max	50	—	—	—
*Mean Particle Size, polymer– Å	1400 – 2500	—	—	—
Coagulum, % max	0.10	—	X	X
*Freeze-Thaw Stability, coagulum % max	0.10	—	X	X
Infrared Spectra of Latex Film	Match Original	—	X	X
Infrared of Alcohol, Soluble Portion of Latex	Match Original	—	X	X
Shelf Life, min	1 yr	—	X	—

Note 1: Quality assurance tests shall be conducted as specified in MSMT 612 except those denoted by an * (asterisk) shall be conducted as specified in FHWA RD – 78-35.

Note 2: The original or prequalification sample shall be accompanied by the producer's certification on all of the tests and properties noted above. The certification shall contain actual test values of the product and the infrared spectrograph.

Note 3: A separate certification is required for each lot of material. The document shall note the date of manufacture, lot size, and whether or not the material is identical to the formulation of the original sample.

TABLE G – LATEX MODIFIED CONCRETE PHYSICAL PROPERTIES			
TEST PROPERTY	TEST VALUES	QUALITY ASSURANCE TESTS	
		PREQUALIFIED TESTS	CONTROL AND ACCEPTANCE
7 Day Compressive Strength, psi min	3000	X	X
28 Day Compressive Strength, psi min	3500	X	—
42 Day Compressive Strength, psi min	3500	X	—
7 Day Flexural Strength, psi min	550	X	—
28 Day Flexural Strength, psi min	650	X	—
42 Day Shear Bond Strength, psi min	2000	X	—
Durability Factor, 300 cycles, % min	85	X	—
Chloride Permeability, Ppm max	510	X	—
Scaling Resistance, 50 cycles, max	3	X	—

Note 1: Quality assurance tests shall be conducted as specified in MSMT 721.

Note 2: Seven (7) Day Compressive Strength Test will be used for Control & Acceptance of the material. The strength level of three thousand (3000) psi at seven (7) days shall be the minimum specified design strength. The mix design approval and acceptance will be based on a coefficient of variation of ten percent (10%) with a probability of one in ten (1 in 10) tests falling below the specified strength. No test value shall fall below eighty percent (80%) of the specified strength.

F. Deformed Reinforcement: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615 or A 706, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to 03 30 00, Part 2, (Portland Concrete Cement Structures).

G. Plain Reinforcement: Unless otherwise specified, dowel bars and dowel bars used as ties in PCC pavement expansion and contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated. Epoxy powder shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures). All dowel bars used for traverse joints shall have maximum pullout strength in conformance with M 254.

H. Stainless Steel Bar: In lieu of epoxy coated plain bars, the Contractor may use stainless steel bars. Deformed bars shall be stainless steel when specified in the Contract Documents. Stainless steel shall conform to A 276, Type SM-29. Deformed stainless steel bars shall conform to A 615 for cross sectional area and deformations.

I. Sleeves for Dowel Bars in Pavement Expansion Joints: Sleeves for dowel bars shall be of sheet metal capable of sliding over two inches (2″), plus or minus one quarter inch (± 1/4″) of the dowel and shall have a closed end with a stop to hold the end of the sleeve at a minimum distance of 1 inch from the end of the dowel bar.

J. Welded Steel Wire Fabric: Welded steel wire fabric shall conform to M 55. Fabric used in pavement construction shall be furnished in flat sheets.

K. Welded Deformed Steel Wire Fabric: Welded deformed steel wire fabric shall conform to M 221.

L. Fabricated Steel Bar Mats: Fabricated steel bar mats shall consist of steel conforming to A 184.

M. Wire Fabric for Pneumatically Applied Mortar: Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.4 wire on three inch (3″) centers in each direction or from W0.9 wire on two inch (2″) centers in each direction. Galvanized coating for fabric, ties, and connecting wire shall not be less than eight-tenths (0.8) oz/ft^2 when tested as specified in A 90.

N. Cold Drawn Steel Wire: Cold drawn steel wire for concrete reinforcement shall conform to M 32.

O. Tie Devices for Concrete Pavement: Tie device sizes shall be as specified in the Contract Documents and produce a frictional force of at least one-hundred sixty (160) lb/ft per foot of spacing when tested as specified in MSMT 512.

P. Steel Strand: Steel strand shall conform to M 203, Grade 270, Low Relaxation Strand.

Q. Water. Water shall conform to 03 30 00, Part 2, (Portland Concrete Cement Structures).

PART 3 EXECUTION

3.1 GENERAL

All removed material shall become the property of the Contractor and shall be disposed of at approved spoil areas.

3.2 EQUIPMENT

A. All equipment proposed for use by the Contractor shall be approved by the Engineer prior to use and shall conform to the following:

1. Deck Removal Equipment.

a. Existing Wearing Surface Removal. This equipment shall only be required when the existing bridge contains a hot mix asphalt wearing surface. It shall be capable of removing the wearing surface without damaging armored joints that are to remain or the existing concrete surfaces beyond the specified minimum removal depth. When pavement breakers are proposed, broad faced chisel blades shall be used and operated at a slight angle with the horizontal to peel the wearing surface off.

b. Deck Surface Removal. Power operated mechanical type or high pressure water jet type equipment shall be capable of uniformly removing the specified minimum depth from the existing concrete surface.

1) Mechanical Type. This equipment shall be limited to depths not closer than one-half inch (1/2″) from the top of the existing reinforcement. When additional removal is required, it shall be

performed by high pressure water jet, power driven hand tools, or hand tools.

2) High Pressure Water Jet. This equipment may be used to any depth above and below the reinforcement steel. The runoff water shall be satisfactorily controlled to prevent it from reaching any traveled roadway, waterways, or any other areas designated in the Contract Documents or by the Engineer. Insufficient means of controlling runoff water or the concrete removal depth may be cause for rejection of this equipment. When this is the case, the Contractor shall revert to the mechanical type, power driven hand tools, or handchipping at no additional cost to the City. However, the Contractor shall revert only to the mechanical type equipment for removal of the specified minimum depth when the specified minimum depth is at least one-half inch (1/2″) above the existing reinforcement.

c. Power Driven Hand Tools. This equipment shall be used for removal of unsound concrete or to achieve the required depth when deeper than one-half inch (1/2″) above the top of existing reinforcement. This equipment will be permitted with the following restrictions:

2. Pavement breakers heavier than nominal thirty (30) lb class are prohibited.
3. Pavement breakers or mechanical chipping tools shall not be operated at an angle in excess of forty-five (45) degrees measured from the surface of the deck.
4. Chipping hammers heavier than a nominal fifteen (15) lb class shall not be used to remove concrete from beneath any reinforcement bars.

a. Hand Tools. Hand tools such as hammers and chisels shall be provided for removal of remaining particles of unsound concrete from beneath any reinforcement bar or to achieve the required depth.
b. Abrasive Blasting. This equipment shall be capable of removing rust scale and old concrete from reinforcement bars and of removing small chips of concrete partially loosened by the removal operation.

5. LMC Proportioning and Mixing Equipment. Equipment used for mixing shall be self-contained, mobile, continuous mixing, and subject to the following:

a. The mixer shall be self-propelled and be capable of carrying sufficient unmixed dry bulk cement, sand, coarse aggregate, latex modifier, and water to produce on the site a minimum of six (6) yd^3 of concrete. Storing aggregate in the mixing equipment overnight is prohibited.
b. The mixer shall be capable of positive measurement of cement being introduced into the mix, have a recording meter visible at all times, and be equipped with a ticket printout which shall indicate the quantities being mixed.
c. The mixer shall be calibrated to accurately proportion the mix. Certification of the calibration by an approved testing authority will be accepted as evidence of the accuracy if the yield is shown to be true within a tolerance of one percent (1.0%) in conformance with MSMT 558.
d. The mixer shall provide positive control of the flow of water and latex emulsion into the mixing chamber. Water flow shall be indicated by flow

meter and be readily adjustable to provide for minor variations in aggregate moisture.

e. The mixer shall be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine.

f. The mixer shall be capable of spraying water over the entire placement width as it moves ahead to ensure that the surface to be overlaid is wetted to receive the LMC.

6. Placing and Finishing Equipment. The combination of labor and equipment for proportioning, mixing, placing, and finishing LMC shall conform to the following minimum requirements except when otherwise specified in the Contract Documents:

TOTAL OVERLAY AREA PER BRIDGE yd^2	MINIMUM OVERLAY RATE PER HR yd^3
0-328	1.0
329-492	1.5
493-656	2.0
over 656	2.5

a. Placing and finishing equipment shall include hand tools for placement and brushing in freshly mixed LMC mortar and for distributing it to approximately the correct level for striking off with the screed.

b An approved finishing machine shall be used for finishing all areas of Work. The finishing machine shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse. A rotating cylinder type finishing machine shall be used. It shall be equipped with one or more rotating steel cylinders, augers, and vibratory pans and span the placement transversely.

c. The finishing machine shall be designed so that when LMC is being mixed and placed under normal operating conditions at the minimum rate, the elapsed time between depositing the LMC on the concrete deck and final screeding shall not exceed ten (10) minutes.

d. The construction shall be supervised by a representative of the manufacturer of the LMC mixture or as directed by the Engineer.

3.3 DECK REMOVAL AND REPAIRS

A. Removal shall be performed to the limits shown in the Contract Documents. After removal the Engineer will inspect the entire exposed portion of the deck and indicate if any repairs are required including the type and extent of the repair. Deteriorated areas of deck shall be removed down to sound concrete by use of power driven hand tools, hand tools, or high pressure water jet. After completion of removal of deteriorated concrete, remove all rust, oil or other foreign materials detrimental to achieving bond, followed by abrasive blasting and air blast or vacuum as determined by the Engineer.

B. The Engineer will determine any extraneous damage to the existing bridge caused by the Contractor's operations, which the Contractor shall repair at no additional cost to the City.

C. Existing reinforcement steel to be utilized in the finished deck shall conform to 03 21 00, (Reinforcing Steel) except all bars shall be thoroughly cleaned by abrasive blasting. Where the bond between existing concrete and reinforcement steel has been destroyed, or where more than half the diameter of the steel is exposed, the concrete adjacent to the bar shall be removed to a depth that will permit concrete bond to the entire periphery of the exposed bar. This clearance shall be a minimum of one inch (1″) unless lower bar mats make it impractical. Care shall be exercised to prevent cutting, stretching, or damaging any exposed reinforcement steel.

D. Areas from which unsound concrete has been removed shall be kept free of slurry produced by hydromilling of concrete in adjacent areas. Work shall be planned so that this slurry will drain away from all open areas. All slurry shall be removed from prepared areas before proceeding with the surface preparation.

E. Spalled concrete, voids and other defects that are located within the proposed LMC overlay area shall then be repaired in conformance with the methods specified herein. Each repair shall include the removal of the additional deck material, all handchipping, and repairing material. If the Contractor elects to use Mix No. 5/Mix No. 6 concrete to make repairs, the concrete shall be placed even with the top of the remaining deck prior to placing the overlay material. The top surface of these deck repairs shall be given a final textured finish consisting of one-eighth inch (1/8″) wide by one-eighth inch (1/8″) deep transverse corrugations spaced approximately one-quarter inch (1/4″) apart. The method of texturing shall be approved by the Engineer prior to placing the material for the deck repair. The repaired areas shall be covered with wet burlap or wet cotton mats and shall be kept continuously wet for one-hundred twenty (120) hours.

1. Type I Deck Repairs: This repair shall include cavities less than one inch (1″) deep. The cavity may require handchipping, but the void shall be filled with LMC overlay while applying the overlay.
2. Type II Deck Repairs: This repair shall include cavities one to three inches (1″ to 3″) deep which the Contractor has the option of repairing with Mix No. 5 concrete or filling the void with LMC overlay while applying the overlay. Wire fabric shall be placed as specified in the 03 37 19, (Pneumatically Placed Concrete). Wire fabric will not be required for repair areas less than two (2) ft^2.
3. Type III Deck Repairs: This repair shall include areas where the depth of deck removal is over three inches (3″) deep but not full depth. The Contractor may opt to repair with Mix No. 6 concrete or fill the void with LMC overlay while applying the overlay. If the repair crosses a proposed construction joint, a one and one-half inch by three inch (1-1/2″ X 3″) keyway shall be provided at the vertical joint. The Contractor shall furnish and erect temporary protective shields as specified in the 02 41 16.33, (Bridge Demolition) when the depth of removal reaches half of the original concrete deck thickness and deeper removal is anticipated.
4. Type IV Deck Repairs: This repair shall include areas where the depth of deck removal is full depth. In large areas, forms supplied to enable placement of the concrete shall be supported by blocking erected using the stringers. In small areas, forms supplied to enable placement of the concrete/LMC may be suspended from existing reinforcement bars by wire ties.

F. The top surface of all deck repairs shall be even with the top of the remaining deck.

3.4 SURFACE PREPARATION

A. The entire surface shall be thoroughly cleaned and abrasive blasted before placing the overlay. The abrasive blasting shall clean all reinforcement of visible rust and clinging concrete detached from the deck and all areas of concrete against which the overlay is to be placed. Abrasive blasting may be required on the day the overlay is to be placed so that reinforcement is free of visible rust. Abrasive blasting shall not be performed more than twenty-four (24) hours prior to placing the LMC overlay. When the Contractor opts to fill repaired voids with concrete in conformance with above paragraph 3.3, they shall be completely cured prior to performing this surface preparation.

B. The surface shall be further cleaned by air blast followed by flushing with water. Prior to placing the LMC overlay, the surface shall be wetted and kept wet for at least one (1) hour and puddles of free water shall be removed.

3.5 PROPORTIONING AND MIXING LMC MATERIALS

A. Mixers shall be clean and the ingredients accurately proportioned.

B. LMC materials shall be mixed at the site in conformance with the specified requirements for the equipment used. The LMC discharged from the mixer shall be uniform in composition and consistency. Mixing shall be capable of permitting finishing operations to proceed at a steady pace with final finishing completed before the formation of the plastic surface film.

3.6 PLACING AND FINISHING LMC OVERLAY

A. The LMC overlay will be the riding surface of the bridge. The top of the LMC overlay shall be placed to the true as planned line and grade of the roadways. The Contractor shall take all necessary precautions to produce a finished top of LMC overlay that shall be smooth riding by placing the LMC overlay in a manner that meets the grade of the proposed adjoining portions of the new bridge decks and adjoining roadways.

B. Screed rails shall be placed and fastened in position to ensure finishing the new surface to the required profile. Anchorage for supporting rails shall provide horizontal and vertical stability. Screed rails shall not be treated with any compound to facilitate their removal.

C. The location of longitudinal joints may be shown in the Contract Documents. If not shown, the locations shall be as directed by the Engineer based on avoiding joints in the vehicular wheel path as much as practical.

D. The Contractor shall take every reasonable precaution to secure a smooth riding bridge deck in conformance with the 03 30 00, (Portland Cement Concrete Structures). Prior to placement operations, the equipment, procedures, personnel and previous results shall be reviewed with the Engineer and the inspection procedures will be reviewed to ensure coordination. Precautions shall include the following:

1. All surfaces shall be completely cleaned as approved by the Engineer prior to placing the LMC overlay.

2. The LMC mixture shall be brushed onto the wetted, prepared surface. Care shall be exercised to ensure that all vertical and horizontal surfaces receive a thorough, even coating and that the rate of progress is limited so that the brushed material does not become dry before it is covered with additional materials required for the final grade. Brushed material that has dried prior to LMC placement shall be removed and replaced in a manner acceptable to the Engineer. Coarse aggregate that accumulates from the brushing operations shall be disposed.
3. The LMC mixture shall be placed to approximately one-quarter inch (1/4″) above grade and then screeded with an approved power operated finishing machine to the line and grade specified in the Contract Documents. A suitable portable lightweight or wheeled work bridge shall be used behind the finishing operation. Hand finishing may be required along the edge of placements. Joints shall be edge tooled except next to metal expansion dams, curbs, and previously placed lanes.
4. Screed rails and construction bulkheads shall be separated from the newly placed material by passing a pointing trowel along their inside face. The trowel cut shall be for the entire depth and length of screed rails and bulkheads after the mixture has stiffened sufficiently. Metal expansion dams shall not be separated from the overlayment.

3.7 CURING

The surface of the LMC overlay shall be covered with a single layer of clean, wet burlap or wet cotton mat as soon as the surface will support it without deformation. Immediately following covering with wet burlap or wet cotton mat, a four (4) mil layer of polyethylene film shall be placed on the burlap or cotton mat and the surface cured for twenty-four (24) hours. After twenty-four (24) hours, the curing material shall be removed and the LMC air cured for an additional seventy-two (72) hours. White opaque burlap polyethylene sheeting may be substituted for the polyethylene film with approval of the Engineer, but shall not replace the wet burlap or wet cotton mat.

3.8 GROOVING

The operation shall conform to the applicable portions of 03 30 00, Part 3, (Portland Cement Concrete Structures) but shall start after the LMC has been cured in conformance with above paragraph 3.7.

3.9 LIMITATION OF OPERATIONS

A. LMC placement shall conform to the applicable deck placement restrictions specified in the 03 30 00, (Portland Cement Concrete Structures).

B. All traffic (Contractor's or public) is prohibited on the LMC overlay until the curing of the material is completed and the compressive strength test has reached three thousand (3000) psi.

C. LMC and concrete shall not be placed adjacent to an LMC surface course less than ninety- six (96) hours old. This restriction does not apply to a continuation of placement in a lane or strip beyond a joint in the same lane or strip.

D. Grinding or chipping the existing concrete pavement within six feet (6′) of LMC is prohibited until the LMC has cured for a minimum of forty-eight (48) hours.

E. LMC shall not be placed at temperatures lower than forty-five degrees (45°) F. The LMC may be placed at forty-five degrees (45°) F, if rising temperature is predicted, and anticipated for at least eight (8) hours.

F. At temperatures below fifty-five degrees (55°) F, the Engineer will require a longer curing period and conformance with applicable portions of the 03 30 00, (Portland Cement Concrete Structures).

G. LMC that is unsatisfactory shall be removed and replaced at no additional cost to the City. Any day during which the curing temperature falls below forty degrees (40°) F shall not be counted as a curing day. When during the curing period the curing temperature falls below thirty-five degrees (35°) F, the Work may be considered as being unsatisfactory and rejected.

H. During minor delays of one (1) hour or less, the end of the placement may be protected from drying with several layers of wet burlap. A construction dam or bulkhead shall be installed when the delay exceeds one (1) hour in duration. Placement operations may proceed after a period of not less than twelve (12) hours. This restriction does not prohibit continuation of placement provided a gap is left in the lane or strip. The gap shall be of sufficient length for the finishing machine to clear the previously placed LMC overlay.

I. Adequate precautions shall be taken to protect freshly placed LMC overlays from sudden or unexpected rain. All placing operations shall stop when it starts to rain. The Engineer may order the removal and replacement of any material damaged by rainfall at no additional cost to the City. The Engineer will determine what material has been damaged.

J. No linseed oil shall be placed on LMC finished deck surfaces.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all removing and cleaning, abrasive blasting, air blasting, flushing with water, forming, curing, disposal of material removed, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Removal and disposal of existing wearing surface from bridge will be measured and paid for at the Contract Unit Price per square yard for the actual surface area removed from the bridge deck.

C. Removal to the depth specified in the Contract Documents will be measured and paid for at the Contract Unit Price per square yard for the pertinent removal of portions of existing concrete bridge deck item.

D. Deck repairs will be measured and paid for at the Contract Unit Price per square yard for the pertinent type deck repair item. Payment shall also include full compensation for the repair material.

E. Furnishing, placing, finishing and curing of the LMC overlay, will be measured and paid for at the Contract Unit Price per square yard for the pertinent Latex Modified Concrete Overlay

item. The actual areas placed, finished and cured will be measured, exclusive of areas of metal expansion dams exposed on the finished surface.

F. Repair bar for deck reinforcement will be measured and paid for at the Contract Unit Price per linear foot.

G. When traffic bearing surfaces are required, supplying and removal of them and any repairs of damage to existing deck will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

03 37 00 SPECIALTY PLACED CONCRETE

03 37 19 PNEUMATICALLY PLACED CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of removing existing concrete, and furnishing and placing pneumatically applied mortar as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Material: Curing materials shall be burlap cloth, sheet materials, liquid membrane forming compounds, or cotton mats.

1. Burlap: Burlap cloth shall be made from jute or kenaf and conform to M 182, Class 1, 2, or 3.
2. Sheet Materials: Sheet material shall conform to M 171 with the following exceptions:

   a. White Opaque Burlap Polyethylene Sheeting. Tensile strength and elongation requirements are waived. The sheeting shall have a finished product weight of not less than ten (10) oz/yd^2.
   b. White Opaque Polyethylene Backed Nonwoven Fabric. Tensile strength and elongation requirements are waived. The thickness requirements are waived. The finished product weight shall be a minimum of five (5) oz/yd^2.
   c. White Opaque Polyethylene Film. Tensile strength and elongation requirements are waived.

3. Liquid Membrane: Liquid membrane forming compounds shall conform to M 148. Field control testing of the white pigmented curing compounds shall be on the basis of weight per gallon. The samples shall not deviate more than plus or minus three-tenths ($\pm$ 0.3) lb/gal from the original source sample.
4. Cotton Mats: Cotton mats shall consist of a filling material of cotton bats or bats covered with unsized cloth and tufted or stitched to maintain the shape and stability of the unit under job conditions of handling. The filling material for the mats shall

be a cotton bat, or bats made of raw cotton, cotton waste, cotton linters, or combinations thereof, and shall weigh not less than twelve (12) oz/yd^2. The covering shall be either cotton cloth, burlap or jute having the following properties:

a. Cotton cloth covering shall weigh not less than six (6.0) oz/yd^2 and shall have an average of not less than thirty-two (32) threads/inch of warp and not less than twenty-eight (28) threads/inch of filling. The raw material used in the manufacture of the cotton cloth shall be raw cotton, cotton comber waste, cotton card strip waste, or combinations thereof.

b. Burlap or jute covering for cotton mats shall weigh not less than six and four-tenths (6.4) oz/yd^2 and shall have not less than eight (8) threads/inch of warp and not less than eight (8) threads/inch of filling. It shall be the grade known commercially as "firsts" and shall be free from avoidable imperfections in manufacture and from defects or blemishes affecting the serviceability.

B. Reinforcement Steel:

1. The steel manufacturer shall furnish certification for each heat of steel.
2. Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices, shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents.
3. Unless otherwise specified, dowel bars and dowel bars used as ties in portland cement concrete pavement expansion and contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated.
4. Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.5 wire on three inch (3″) centers in each direction or from W1 wire on two inch (2″) centers in each direction. Wire fabric shall be galvanized.
5. Galvanized coating for fabric, ties, and connecting wire shall not be less than eight-tenths (0.8) oz/ft^2 when tested as specified in A 90.
6. Epoxy powder shall conform to the following:

   a. The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss.

7. Epoxy coatings shall conform to D 3963.
8. Material used for the touch up system shall be a two (2)-part epoxy system designated and color matched for patching the epoxy coating used. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.

9. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

C. Anchor Bolts: Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.

D. Water: Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed the following limits:

Bridge Superstructure and Prestressed Concrete	500	ppm
Latex Modified Concrete	50	ppm
Other Concrete and Water Used in Curing	1000	ppm

E. Cement: Cement shall be Type II conforming to M 85, with the fineness and the time of setting determined in conformance with T 131 and T 153, respectively, and shall be furnished in the original ninety-four (94) lb paper sacks supplied from the cement manufacturer.

F. Fine Aggregate: Fine aggregate shall conform to the Fine Aggregate Portland Cement Concrete requirements in the following tables. Maximum moisture content of fine aggregate shall be six percent (6%) by weight.

FINE AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

Material	Sieve Size				
	3/8"	No. 4	No. 16	No. 50	No. 100
Portland Cement Concrete Underdrain, and Pneumatic Motor	100	95–100	45–85	10–30	0–10

FINE AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

SPECIFICATION	T 104	T 112	T 11	T 113	T 21
	SODIUM SULFATE SOUNDNESS	CLAY LUMP & FRIABLE PARTICLES	MATERIAL FINER THAN No. 200 SIEVE	COAL & LIGNITE	ORGANIC IMPURITIES
	% max	% max	% max	% max	% max
M 6 CLASS B	10	3.0	4.0(a)	1.0	3.0

Note (a): 5.0 for concrete not subject to surface abrasion.

G. Mortar Mixes: Pneumatically applied mortar shall have a twenty-eight (28) day compressive strength of five thousand to nine thousand (5000 to 9000) psi. All mixes shall be approved by the Engineer prior to starting Work.

2.2 TEST PANELS

A. When specified in the Contract Documents, test panels of various mix combinations, admixtures, and materials shall be prepared and cured by the Contractor. One (1) test panel shall be prepared for every one hundred (100) ft^3 of mortar in place. Additional test panels shall be prepared as directed by the Engineer. Each panel shall be thirty-six inches (36″) square and eight inches (8″) deep. At least half of each panel shall contain the same reinforcement as the structure. A separate panel shall be fabricated by each application crew using the equipment for each mix design and in each shooting position encountered.

B. The Contractor shall be responsible for the preparation and curing of all test panels. The Contractor shall core each test panel and the cores shall be delivered to the laboratory for testing. Cores shall have a minimum diameter of four inches (4″) and a minimum length of eight inches (8″). Each core will be tested in compression at seven (7), fourteen (14), and twenty-eight (28) days. Core strength correction will conform to T 24.

C. The cut surface of each specimen will be examined by the Engineer. Additional surfaces shall be exposed by sawing or breaking the panel when this is considered necessary to check soundness and uniformity of the material. All cut or broken surfaces shall be dense and free from lamination and sand pockets.

PART 3 EXECUTION

3.1 GENERAL

A. The Contractor's proposed methods of protecting the public against injury and damage from demolition operations to remove deteriorated concrete shall be submitted to the Engineer and approved prior to beginning removal operations. Whenever protective shields are required, they shall conform to the following:

1. The Contractor shall protect the public against injury and damage from demolition operations when removing portions of existing bridge deck slabs. When deck removal is performed over or near roadways, railroads or waterways, the Contractor shall furnish and erect temporary protective shields to prevent any material or debris from entering these areas.
2. The Contractor shall adhere to the under clearance restrictions. The requirements for under clearances at structures shall apply to the entire usable roadway areas including shoulders. Unless otherwise specified in the Contract Documents or directed by the Engineer, the Contractor shall ensure that the following under clearances are maintained.

    a. All bridges (except pedestrian bridges) over Interstate, United States, or State highways shall have a sixteen foot (16′) minimum vertical under clearance.
    b. All bridges (except pedestrian bridges) over secondary/county roads and local roads shall have a fourteen and one-half foot (14-1/2′) minimum under clearance.

c. Pedestrian bridges shall have a minimum vertical under clearance one foot (1′) higher than those specified above. However, if there are bridges in the general vicinity of the proposed pedestrian bridge that have an under clearance greater than the minimum required under clearance of the pedestrian bridge, then the pedestrian bridge will have its under clearance increased to equal the highest overpass bridge. Removal of existing pavement under an existing pedestrian bridge to conform to the one foot (1′) higher requirement will not be required unless specified in the Contract Documents

d. All bridges with overhead structural elements (e.g. through truss bridges, movable bridges with overhead bracing for counterweights, etc.) shall have a seventeen and one-half foot (17-1/2′) minimum overhead vertical clearance.

3. When the above requirements are not met, the Contractor shall take remedial actions as directed by the Engineer. When remedial actions are required, and there are no pay items for the Work in the Contract Documents, negotiated payment provisions shall apply. The cost of measurements to determine clearance heights will be incidental to other pertinent items in the Contract Documents.

4. A minimum of sixteen feet (16′) under clearance shall be maintained at all bridges throughout construction over each lane or shoulder open to traffic. No portion of formwork, temporary protective shields, etc. including connection devices shall encroach on this under clearance. If less than sixteen feet (16′) vertical under clearance is provided on bridges specified in a. or d. above, the Engineer will notify the City of the exact reduced minimum clearance and the effective dates of the reduction. The Contractor shall furnish and erect signs indicating the exact minimum under clearance. The signs and their locations shall be approved by the Engineer. Signs shall be removed and become the property of the Contractor when the intended under clearance is restored.

5. Working Drawings for the protective shields shall be submitted. Working Drawings for the protective shields (design and construction) shall be the responsibility of the Contractor, including submitting and obtaining written acceptance of the design and plans by the Engineer before erection.

6. The Contractor shall utilize a professional engineer (P.E.) registered in the State of Maryland who has a minimum of five (5) years experience in falsework design for bridge construction and repair. The falsework design calculations and plans shall be signed by the P.E. and bear the seal of the P.E. The submittal of the design and falsework plans shall include the P.E.'s resume showing evidence of the required experience.

7. The P.E.'s plans and design calculations shall evaluate and qualify all products and components including manufactured products and proprietary items for their intended service. Acceptance by the Engineer of falsework systems shall not in any way relieve the Contractor of the responsibility for the safety and adequacy of the design and construction for the falsework systems and operations, including all components.

8. Every structure in the construction Contract will require a separate falsework design analysis, separate plans, and design submittal as set forth above. This applies even though structures may appear to be identical.

9. Each falsework system shall be designed to support all vertical and horizontal loading with enough redundancy to prevent progressive failure. Vertical loading, differential settlement forces, live load where applicable, and all horizontal lateral and longitudinal forces shall be taken into account. Unbalanced temporary loading

caused by placement sequence shall also be provided for in the design. Adequate diagonal bracing in all planes shall be employed.

10. All falsework systems designs and plans shall provide for adequate foundations with bearings below the frost line or on rock or on piling and for possible settlement. If additional subsurface data is necessary, it shall be obtained and analyzed for proper design of the plans and performance of construction.
11. Falsework designs and plans shall include protection against impact from uncontrolled highway vehicles, accidental collision of a crane boom or other construction equipment and vehicles, traffic vibration, floodwaters, high winds, and any other envisioned contingent situations.
12. Flooring and siding shall have no cracks or openings through which material particles may pass. The shields shall be able to support over their entire area one-hundred fifty (150) lb/ft^2 in addition to their own dead weight.
13. After the Engineer determines that the protective shields have served their purpose, they shall be removed and become the property of the Contractor.

B. The Contractor shall provide safe access to all areas of the existing structure to be repaired. Prior to the start of any repair Work, the Contractor, in the presence of the Engineer, shall conduct a full and thorough inspection of the areas to be repaired. The purpose of this inspection will be to identify the location and extent of each area of concrete deterioration and repair. The extent of removal and the determination of when sound concrete is encountered shall be as established by the Engineer.

C. Restrictions: The Contractor shall wait seventy-two (72) hours minimum after completing repairs to a section of a stringer or pier before chipping on any section that has a common side or point.

D. If at any time an area is identified as having deteriorated concrete beyond the following limits, all Work shall immediately stop, and the Engineer will be notified. Work in these areas will not be permitted to resume until approval has been obtained from the Engineer.

1. A maximum depth of six inches (6″) behind the original finish surface.
2. A maximum depth of three inches (3″) behind the reinforcement steel.
3. A maximum depth of one inch (1″) under the bearing.

3.2 EQUIPMENT

A. All equipment shall be capable of thoroughly mixing all material used and shall be calibrated.

B. The mixer shall be self-cleaning and capable of discharging all mixed material without any carry over from one batch to the next. Mixing equipment shall be cleaned at least once a day.

C. The air compressor shall be of ample capacity to maintain a supply of clean, dry air adequate to provide the required nozzle velocity for all parts of the Work, while simultaneously operating a blowpipe for cleaning away rebound.

D. The air and water pressure shall be constant and not pulsate.

3.3 STORAGE

A. Storage and handling of cement shall conform to Contract Documents and as directed by the Engineer. Sand shall be stored to prevent segregation or contamination of the material.

B. Regardless of the type of surface the bundles are to be stored upon, all bundles shall be stored at the site on suitable blocking or platforms at least four inches (4″) above the surface or vegetation. The reinforcement shall be kept free of dirt, oil, grease, paint, and other foreign matter.

3.4 SURFACE PREPARATION

A. The deteriorated areas of concrete shall be removed to sound concrete with a thirty (30) lb maximum chipping hammer. Chipping shall continue to a minimum depth of one inch (1″) behind the reinforcement steel until there are no sudden changes in the depth of the cavity. The perimeter of the cavity shall consist of a shoulder that is perpendicular to the surface of the structure for a minimum depth of one inch (1″).

B. After the Engineer has determined that the cavity surface is sound, it shall be abrasive blasted. Just prior to mortar application, all surfaces shall be thoroughly cleaned, followed by wetting and damp drying.

C. The Contractor shall contain all blast waste and loose concrete and promptly remove it to an approved disposal site. Blast waste and loose concrete shall be kept out of waterways.

3.5 REINFORCEMENT

A. If sound concrete is encountered before the reinforcement steel is exposed, then sound concrete shall be removed to a depth of one inch (1″) behind the existing reinforcement steel. If sound concrete is found within three and one-half inches (3-1/2″) of the proposed finished surface, the removal shall stop and additional No. 4 reinforcement bars shall be dowelled and installed at twelve inches (12″) center to center horizontally and vertically, and two inches (2″) clear of proposed finished surface.

B. Holes shall be drilled only in the solid portion of the masonry, and are prohibited at points where cracks exist. Drilled holes shall be a minimum of six inches (6″) from the face of any masonry surface. The minimum size of dowel bars shall be No. 6. The holes shall be drilled at least one-half inch (1/2″) larger than the outside diameter of the insert to be grouted. Holes shall be cleaned and then filled two-thirds full of grout. The insert shall be placed and allowed to set for twenty-four (24) hours. The grout shall conform to any type specified in the following:

1. Mortar used for grouting anchor bolts, pipe, handrail posts, and miscellaneous items shall be composed in conformance with one of the following:

    a. One (1) part portland cement or blended hydraulic cement and one (1) part mortar sand by dry loose volume.
    b. Prepared bag mixes consisting of portland cement or blended hydraulic cement and mortar sand. The prepared mixes shall produce a mortar

conforming to the strength requirements specified in the Contract Documents.

c. Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of five thousand (5000) psi in seven (7) days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of zero percent (0.0%) after seven (7) days when tested as specified in T 160.

d. Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of six thousand five hundred (6500) psi in seventy-two (72) hours when tested as specified in Maryland Standard Methods of Tests (MSMT) 501. Sand for epoxy grout shall conform to M 45.

e. An epoxy or polyester anchoring system may be used when approved by the Engineer in conformance with the manufacturer's recommendations. Strength values shall be as specified in the Contract Documents.

C. All exposed existing reinforcement steel that will be incorporated in the new Work shall be abrasive blasted to a near white finish to remove all rust, dirt, scale, and loose concrete. All deteriorated reinforcement bars that have lost twenty percent (20%) or more of their original dimension shall be cut out and new bars welded in their place. Dual bars of equivalent or greater section may be used. New reinforcement steel shall be welded to existing reinforcement steel as specified in the Contract Documents. The Engineer will establish if reinforcement steel is to be reused or replaced.

D. All areas to be repaired shall be reinforced with wire mesh in addition to the reinforcement steel.

E. For anchoring reinforcement to masonry surfaces, expansion bolts not less than three-eighths inch (3/8″) in diameter shall be set in drilled holes, or plain round No. 4 bars shall be set in approved dry packed mortar tightly driven in drilled holes. Drilled holes shall not be less than three inches (3″) deep. All bolts or bars shall be set in solid masonry (not in mortar, joints, or cracks) and shall have heads or hooks on their outer ends. Where approved by the Engineer, wire mesh reinforcement may be wired to existing reinforcement without the use of expansion bolts.

F. Mesh shall be cut in sheets of proper size, and the separate sheets shall be bent over templates so as to follow closely the outlines of the member or surface to be covered. It shall be securely held in a uniform position by being tied with fourteen (14) gauge black annealed wire to the bolts or bars. Ties shall be spaced at twelve inches (12″) maximum.

G. Where adjacent sheets of mesh join, they shall overlap at least two (2) squares of the mesh and be tied together at intervals not exceeding eighteen inches (18″) with fourteen (14) gauge black annealed wire.

3.6 GUIDES

Sufficient guides shall be provided to obtain the full thickness of mortar specified to ensure uniform and straight lines.

3.7 MIXING AND SCREENING

The cement and sand shall be uniformly dry mixed in a batch mixing machine. Mixed materials that are not applied as mortar within one (1) hour after being mixed shall be discarded. After the materials are dry mixed and before being charged into the placing machine, the mixture shall be passed through a three-eighths inch (3/8") screen.

3.8 APPLICATION

A. Each layer shall be built up by several passes of the nozzle over the working area. The mixture shall emerge from the nozzle in a steady, uninterrupted flow. Should the flow become intermittent for any cause, it shall be directed away from the Work until it becomes constant. The distance of the nozzle from the Work shall be as required to give best results for the conditions, and shall be held perpendicular to the application surface. When shooting through reinforcement, the nozzle shall be held at a slight angle from perpendicular to permit better encasement.

B. The application of the mixture to vertical surfaces shall begin at the bottom. The first layer shall at least completely embed the reinforcement.

C. Rebound shall not be worked back into the construction, or be salvaged and included in later batches.

D. Rebound and overspray shall not be allowed to fall into waterways and shall become the property of the Contractor, who shall dispose of this material in an approved disposal site at no additional cost to the City.

E. When a layer of pneumatically applied mortar is to be covered by a succeeding layer, it shall first be allowed to take its initial set. Then all laitance, loose material, and rebound shall be removed by brooming. Any laitance that has been allowed to take final set shall be removed by abrasive blasting and the surface cleaned with an air water jet. In addition, the surface will be sounded by the Engineer with a hammer for hollow sounding areas resulting from rebound pockets or lack of bond.

3.9 CURING AND COLD WEATHER PROTECTION

A. Cold Weather Protection. Mortar shall be protected and heated after it has been placed when the air temperature in the shade and away from artificial heat drops to forty degrees (40°) F or lower at the time of placing or at any time within the number of days specified herein. Protection and heating shall be as follows:

1. Mortar shall be protected and kept continuously at a temperature not less than fifty degrees (50°) F for at least seven (7) days following placement.
2. In no case shall mortar be heated to more than one hundred degrees (100°) F. At the end of the heating period, the mortar surfaces shall be cooled to the temperature of the outside air by slowly reducing the artificial heat at a uniform rate until the temperature of the outside air is reached within a twenty-four (24) hour period.
3. The Contractor shall have tarpaulins, insulating devices, and other suitable materials at the site to enclose or protect all portions of the mortar requiring protection. Materials shall be installed as close as possible before placing the

mortar, and it shall be installed as rapidly as possible to keep exposure to cold weather to a minimum. Where heating is required, the spaces to be heated shall be completely enclosed and the temperature kept at required levels by the use of heaters approved by the Engineer.

4. The Contractor shall provide a sufficient number of maximum/minimum recording thermometers to record temperatures in each mortar placement undergoing cold weather protection.

B. Mortar shall be kept continuously wet for at least seven (7) days after application. The use of a liquid membrane forming compound will be permitted with prior approval of the Engineer.

3.10 FINISHING

The area of repair on existing structures shall be finished to match the existing structure.

PART 4 MEASUREMENT AND PAYMENT

Pneumatically Applied Mortar will be measured and paid for at the Contract Unit Price per cubic foot of mortar in place. The payment will be full compensation for inspections, removal of existing concrete, abrasive blasting, and furnishing all cement, sand, water, test panels, drilled holes, reinforcement bars, wire mesh, mortar, expansion bolts, cores, storage, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

03 41 00 PRECAST STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and placing all prestressed concrete beams and slab panels, elastomeric bearing pads, bearing plates and embedded items, all steel strands, jacks, and other devices required to provide in place the finished member in conformance with the Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fine Aggregate including natural and manufactured sand shall conform to the following Tables A and B.

B. Coarse Aggregate shall conform to the following Tables A and B.

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

MATERIAL		SIEVE SIZE										
		1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No. 50	No. 100	No. 200
COARSE AGGREGATE PORTLAND CEMENT CONCRETE and UNDERDRAIN	57	100	95–100	—	25–60	—	0–10	0–5	—	—	—	—
	67	—	100	90–100	—	20–55	0–10	0–5	—	—	—	—
	7	—	—	100	90–100	40–70	0–15	0–5	—	—	—	—
FINE AGGREGATE — PORTLAND CEMENT CONCRETE, UNDERDRAIN, and PNEUMATIC MORTAR		—	—	—	—	100	95–100	—	45–85	10–30	0–10	—
COARSE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	100	90–100	—	10–50	0–15	—	—	—	—	—
FINE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	—	—	—	100	85–100	—	40–80	10–35	5–25	—
FINE AGGREGATE/SAND MORTAR AND EPOXIES		—	—	—	—	—	100	95–100	—	—	0–25	70–100

TABLE B – AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

MATERIAL TYPE I	TEST METHOD									
	SPECIFICATION	T 104	T 112	T 113	T 112 & T 113	T 11	T 113	D 4791 (a)	T 96	T 21
		Sodium Sulfate Sound-ness	Clay Umps & Friable Particles	Chert Less Than 2.40 Sp Gr	Sum of Clay Lumps, Friable Particles & Chert	Materials Finer Than No. 200 Sieve	Coal & Lignite	Flat & Elongated	Los Angeles Abrasion	Organic Impurities
		% max	% max	% max	% max	% max	% max	% max	% max	% max
COARSE AGGREGATE PCC (a)	M 80 CLASS A	12	2.0	3.0	3.0	1.0(c)	0.5	12	50	—
FINE AGGREGATE PCC (a)(b)	M 6 CLASS B	10	3.0	—	—	4.0(d)	1.0	—	—	3.0
COARSE AGGREGATE LIGHTWEIGHT PCC	M 195	—	2.0	—	—	—	—	12	—	—
FINE AGGREGATE LIGHTWEIGHT PCC (c)	M 195	—	2.0	—	—	—	—	—	—	3.0
FINE AGGREGATE/ SAND MORTAR AND EPOXIES	M 45	10	1.0	—	—	—	0.5	—	—	3.0

Note (a): Coarse and Fine Aggregate for PCC shall be tested for alkali silica reactivity (ASR) as specified in MSMT 212.

Note (b): In areas exposed to traffic, manufactured sand shall have a minimum ultimate polish value of eight (8), based on the parent rock.

Note (c): Fine aggregate conforming to M 6 may be used if the lightweight concrete does not exceed the maximum unit weight specified in the Contract Documents.

Note (d): 5.0 for concrete not subject to surface abrasion.

C. Cement: Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 131 and T 153, respectively.

D. Admixtures:

1. Air Entraining: Air entraining admixtures shall conform to M 154.
2. Retarding: Chemical admixtures shall conform to M 194, Type A, D, or nonchloride C.
3. Water Reducing:

   a. Chemical Admixtures: Chemical admixtures shall conform to M 194, Type A, D, or nonchloride C.
   b. High Range Water Reducing Admixtures: High range water reducing admixtures shall be liquid and shall conform to M 194, except that the water content shall be a maximum of eighty-five percent (85%) of that of the control, and the durability factor shall be a minimum of ninety (90). Type F shall be used for early strength and shall produce a minimum compressive strength in twelve (12) hours of one-hundred eighty percent (180%) of that of the control. Type G shall be used when early strength is not specified. The manufacturer shall furnish certification which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification shall include curves indicating the fluid ounces of admixture per one hundred (100) lb of cement as related to water reduction and strength gain for twelve (12) hours when used with a minimum cement factor of seven hundred (700) lb.

4. Pozzolans:

   a. Pozzolans: The Contractor may request the use of pozzolans to control alkali silica reactivity or for other reasons. When a pozzolan is used, the minimum cement factor and water/cement ratio shall be determined on the basis of the combined weight of cement and pozzolan.
   b. See the following table for percentage of fly ash, ground iron blast furnace slag, and microsilica.

OPTION	ALKALI CONTENT OF CEMENT % max	REPLACE CEMENT WITH		SPECIFICATION
		MATERIAL	BY WEIGHT	
1	1.50	Class F Fly Ash	15 – 25	M 295
2	1.50	Ground Iron Blast Furnace Slag	25 – 50	M 302 Grade 100 or 120
3	1.50	Microsilica	5 – 7	C 1240
4	—	Blended Cement (a)	100	M 240
5	0.60 (b)	Low Alkali Cement	100	M 85

c. Fly Ash shall conform to M 295, pozzolan Class C or F, except that the maximum permissible moisture content shall be one percent (1.0%), and when used in concrete Mix Nos. 3 and 6 the loss on ignition shall not exceed thirty percent (30%).

d. Ground Iron Blast Furnace Slag shall conform to M 302, Grade 100 or 120.

e. Microsilica shall conform to C 1240, except that the oversize requirement is waived.

f. Ground Iron Blast Furnace Slag shall conform to M 302, Grade 100 or 120. The Contractor may request to substitute a maximum of fifty percent (50%) of the weight of cement with ground iron blast furnace slag. When ground iron blast furnace slag is used, the minimum cement factor and water/cement ratio will be determined on the basis of the combined weight of the cement and ground iron blast furnace slag.

5. Mixing Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed the following limits:

Bridge Superstructure and Prestressed Concrete	500	ppm
Latex Modified Concrete	50	ppm
Other Concrete and Water Used in Curing	1000	ppm

E. Shear Key Grout: Mortar used for grouting anchor bolts, pipe, handrail posts, and miscellaneous items shall be composed in conformance with one of the following:

1. One (1) part portland cement or blended hydraulic cement and one (1) part mortar sand by dry loose volume.
2. Prepared bag mixes consisting of portland cement or blended hydraulic cement and mortar sand. The prepared mixes shall produce a mortar conforming to the strength requirements specified in the Contract Documents.
3. Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of five thousand (5000) psi in seven (7) days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of zero percent (0.0%) after seven (7) days when tested as specified in T 160.
4. Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of six thousand five hundred (6500) psi in seventy-two (72) hours when tested as specified in Maryland Standard Methods of Tests (MSMT) 501. Sand for epoxy grout shall conform to aforementioned paragraph 2.1 A.
5. An epoxy or polyester anchoring system may be used when approved by the Engineer in conformance with the manufacturer's recommendations. Strength values shall be as specified in the Contract Documents.

F. Reinforcement Steel: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents.

G. Welded Steel Wire Fabric: Welded steel wire fabric shall conform to M 55. Fabric used in pavement construction shall be furnished in flat sheets.

H. Prestressing Strand: Steel strand shall conform to M 203, Grade 270, Low Relaxation Strand.

I. Elastomeric Bearing Pads:

1. Elastomeric bearing pads shall conform to the material requirements described in the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges. The elastomeric bearing shall be sixty (60) durometer hardness, Shore Type A. Accompanying the certificate for elastomeric bearing pads shall be two (2) standard ASTM tensile slabs molded from the same compound batch as the furnished elastomeric bearings.
2. The static load deflection of any layer of elastomeric bearing pads shall not exceed seven percent (7%) at eight hundred (800) psi average unit pressure when tested under laboratory conditions.
3. The design load for the elastomeric bearing pads will be specified in the Contract Documents. The manufacturer shall proof load each steel reinforced bearing design with a compressive load of one and one-half (1-1/2) times the maximum design load and shall specify that the material conforms to the material certification.
4. When test specimens are cut from an actual bearing pad, a reduction of 10 percent in the minimum requirements for original tensile strength and ultimate elongation will be required.

J. Closed Cell Neoprene Sponge Elastomer: Closed cell neoprene sponge elastomer shall conform to D 1056, Type S. Skin coating is optional. The material shall conform to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Compression Deflection, D 1056	Pressure necessary for 25% deflection, 5 – 10 psi, one layer 1/2 inch thick pad @ 70° ± 5° F
Accelerated Aging Test	Change in compression deflection after aging 7 days @ 158° F, 20% max
Permanent Set*, D 1056	50% deflection @ 158° F for 22 hr, 40% max residual permanent set after 10 days recovery, 10% max
Water Absorption by weight	2 inch immersion of 1.129 inch diameter sample for 24 hr @ room temperature, 10% max
Water Resistance, D 1171	Quality retention, 6 weeks exposure, 100 %

*Method to calculate permanent set: (see next page)

$$\text{Permanent set} = \frac{(t_0 - t_1) \times 100}{t_0}$$

where:

t_0 = original thickness of sample, and

t_1 = thickness of specimen thirty (30) minutes after removal of clamps or after ten (10) days recovery.

K. Fusion Bonded Epoxy Powder Coating for Steel: The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal Specifications. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. Epoxy coatings shall conform to D 3963.

1. Touch Up System. Material used for the touch up system shall be a two (2) part epoxy system designated and color matched for patching the epoxy coating used.
2. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.
3. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

The certification or data sheet shall show actual test results for each required property of the type, grade, and class of epoxy submitted, and shall accompany each sample.

L. Epoxy Adhesive

1. Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and contain no volatile solvents, lumps, or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging.
2. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.
3. The certification or data sheet shall show actual test results for each required property of the type, grade, and class of epoxy submitted, and shall accompany each sample.
4. The manufacturer shall supply actual bond test results for each batch submitted for use.

M. Anchor Rod Dowel Bars shall conform to A 242.

N. Threaded Tie Rods shall conform to A 663, Grades 300 thru 410.

O. Concrete Protective Coatings shall conform to the Contract Documents.

2.2 PORTLAND CEMENT CONCRETE

A. The composition, proportioning, and mixing of concrete shall produce a homogeneous concrete mixture of a quality that will conform to the materials and design requirements specified in the Contract Documents.

B. The required cylinder strength of the concrete at transfer of the tensioning load and the minimum required cylinder strength of the concrete at twenty-eight (28) days will be specified in the Contract Documents. The concrete mix shall contain an air entraining admixture and a Type D or G admixture.

C. Type G high range water reducing admixtures may only be used if the Engineer determines that the producer can design and show by trial mix that the concrete conforms to the strength requirements specified in the Contract Documents and the following:

1. Maximum slump of six inches (6″).
2. Air content of five and one-half percent (5-1/2%) plus or minus one and one-half percent (± 1-1/2%).
3. Minimum cement factor of seven hundred (700) lb/yd^3.
4. Maximum WCM ratio of forty-five hundredths (0.45).

D. The Engineer shall be allowed to take six (6) test cylinders from each member or members cast and cured as a unit for the purpose of checking the quality of the concrete being produced, for determining the time when forms may be removed, and for determining the time when prestressing forces may be applied to a member. These cylinders shall be made in metal or plastic molds and cured with the beams. At least three (3) test cylinders shall be made and cured under laboratory conditions as specified in T 126. Test cylinders shall be made and tested at the manufacturing site, by the manufacturer's quality control technician, in conformance with T 22 and shall be witnessed by the Engineer.

2.3 REINFORCEMENT STEEL AND TIE ROD TUBES

A. All reinforcement steel to extend into the roadway slab shall be epoxy coated.

B. Tie rod tubes shall consist of corrugated, rigid or semi-rigid type, galvanized steel sheathing or rigid plastic sheathing.

2.4 DEBONDING MATERIAL

Material used for debonding of pretensioning steel strands shall be solid or split plastic sheathing having a minimum thickness of twenty-five-thousandths inches (0.025″).

2.5 JOINT SEALERS

Joint sealers shall conform to the manufacturer's specifications.

PART 3 EXECUTION

3.1 WORKING DRAWINGS

When the Contractor elects to use methods other than specified in the Contract Documents, the Contractor shall provide Working Drawings to the Engineer for approval.

The drawings shall include reinforcement, anchorages, steel strand profiles, lifting inserts, and all other pertinent information required. Whether the Engineer accepts or rejects any of the Contractor's proposed changes, the members shall be constructed at no additional cost to the City.

3.2 PRESTRESSED CONCRETE PLANTS

The prestressed concrete manufacturing plant shall be registered and certified under the Precast/Prestressed Concrete Institute Program and a valid certificate shall be submitted to the Engineer prior to the start of production.

3.3 BEDS AND FORMS

A. Casting beds shall be supported on unyielding foundations. The beds and forms shall be cleaned after each use. Accumulation of coatings used for bond breakers shall be prevented.

B. Prior to stringing steel strands, the bottom of forms shall be inspected for cleanliness and accuracy of alignment. The contact surfaces of forms shall be coated with bond breaker that dries to a surface hardness. The coating shall be dry before the steel strand comes in contact with it to prevent contamination of the steel strand.

3.4 MEETINGS

A pre-pour meeting, which shall include a representative of the prestressed concrete plant, shall be held prior to commencement of any prestressed concrete Work.

3.5 PROTECTION OF PRESTRESSING STEEL STRAND

A. Prestressing steel strand shall be stored under shelter and kept free of deleterious material such as grease, oil, wax, dirt, paint, loose rust, or other similar contaminants. Steel showing corrosion, etching, pitting, or scaling of the surfaces shall not be used. A light coating of surface rust is acceptable if it can be removed completely from the steel by wiping with a cloth.

B. Prestressing steel strand shall not be stored on a surface that contributes to galvanic or battery action. Steel strand shall not be used as a ground for electric welding and shall be protected from electric welding sparks.

3.6 REINFORCEMENT STEEL, INSERTS, AND CHAIRS

A. Reinforcement steel shall be placed within the specified tolerances, and shall be secured to beds and forms using chairs, blocking, or ties. Cages of bars shall be fabricated by tying only. Cages shall not be supported by tensioned strands. Tie wire ends shall be bent into the slab panel. The type and placement of inserts shall be shown on the Working Drawings.

B. Form ties, chairs, and inserts shall be recessed in the concrete by at least one inch (1″) or stainless steel accessories shall be used.

3.7 METHODS OF FORCE MEASUREMENT

A. Forces shall be measured using one of the following methods as the primary measuring system and checked by using one of the other methods as the secondary measuring system. Methods of force measurement are:

1. Curves. Current stress-strain or elongation curves furnished by the strand manufacturer may be used. An average modulus may be used if acceptable to the Engineer. Means shall be provided for measuring the elongations of the strands to at least one eighth inch (1/8″).
2. Pressure Gauges. Gauges shall be used to measure force by the pressure applied to hydraulic jacks. These gauges shall be furnished with dials calibrated with the jacking system.
3. Dynamometers. Dynamometers connected in tension to the stressing system for the initial force may be used.

B. Gauging System. Tensioning systems shall be equipped with accurately calibrated hydraulic gauges, dynamometers, load cells, or other devices for measuring the stressing load to an accuracy of reading within two percent (2%). A qualified testing laboratory shall calibrate and issue a certified calibration curve with each gauge. A gauging system shall be recalibrated whenever it shows erratic results, when directed by the Engineer, and at intervals not greater than six (6) months. Gauges for single strand jacks may be calibrated by an acceptable and calibrated load cell. Calibrate gauges for large multiple strand jacks, acting singly or in parallel, by proving rings or by load cells placed on either side of the movable end carriage. All jacks and gauges shall be calibrated by an independent laboratory at no additional cost to the City and documentation forwarded to the Engineer. Pressure gauges and dynamometers shall be provided preferably with full pressure and load capacities of approximately twice their normal working range. Loads shall be limited to a minimum of twenty-five percent (25%) and a maximum of seventy five percent (75%) of the total graduated capacity, unless calibration data establishes consistent accuracy over a wider range. Each gauge shall indicate loads directly in pounds or shall be accompanied by a chart with which the dial reading can be converted into pounds. Tensioning systems employing hydraulic gauges shall be equipped with appropriate bypass pipes, valves, and fittings so the gauge reading remains steady until the jacking load is released. Gauge readings, elongation measurements, and calculations for elongation shall include appropriate allowances for operational losses in the tensioning system due to strand slippage, movement of anchorages and abutments, elongation of abutment anchorage rods, strand rotation, temperature variation, friction, bed shorting, and other forces and influences acting on the strand.

C. Friction in Jacking System. In multiple strand tensioning systems, the sliding surfaces shall be cleaned and lubricated to minimize friction. A force override (compensatory operational loss correction) shall be established for standard strand pattern series.

D. Thermal Effects. The design prestressed force shall be increased by five-tenths percent (0.5%) for each five degrees (5°) F ambient temperature below eighty degrees (80°) F. No adjustment is required when the ambient temperature is above eighty degrees (80°) F. Steel strands shall not be stressed when the ambient temperature is below forty degrees (40°) F. After the steel strands are tensioned, the temperature of the air surrounding the steel strands shall be maintained at forty degrees (40°) F or more until the force is transferred to the concrete.

E. Control of Jacking Force. Either manual or automatic pressure cutoff valves may be used for stopping the jacks at the required load. Automatic cutoffs capable of adjustment shall be used to ensure that the jacking load corresponds to the required load. The setting accuracy for the automatic cutoff valves shall be verified whenever there is reason to suspect improper results and at the beginning of each day's operation.

3.8 STRINGING STEEL STRANDS

A. Steel strands containing former vise grip points shall not be reused unless the points are outside the new steel strand vise locations. Steel strands that have been draped shall not be reused.

B. All steel strands shall have the same lay or direction of twist. The ends shall be cut using shears or abrasive cutting wheels. Steel strands shall be positioned over chairs to eliminate sagging of steel strands in the bottom rows.

3.9 STEEL STRAND SPLICES

There shall only be one (1) splice per steel strand. For single steel strand tensioning, the number of steel strands that may be spliced in each bed is not restricted. For multiple steel strand tensioning, either all strands shall be spliced and the elongation shall be adjusted for average slippage, or no splices are permitted.

3.10 STEEL STRAND VISES

A. Steel strand vises shall be capable of anchoring stressing loads positively with a minimum of slippage and shall be cleaned, lubricated, and inspected between each use. Grips that become visibly worn or distorted, or that allow slippage in excess of one-quarter inch (1/4″) shall not be used. A full set of steel strand vises shall be cleaned and inspected before starting each prestressing operation.

B. The maximum permissible time for holding tensioned steel strands in the bed before placing concrete shall be seventy-two (72) hours.

3.11 WIRE FAILURE IN STEEL STRANDS

Seven (7) wire steel strand with any broken wire shall be removed and replaced. All steel strands shall be checked for wire breaks before placement of concrete.

3.12 PRETENSIONING

A. The total load to be applied to each strand shall be as specified in the Contract Documents. The load shall be applied as a total of two (2) loading stages. The initial load shall straighten the steel strand, eliminate slack, and provide a starting or reference point for measuring elongation.

B. The initial load shall not exceed ten percent (10%) of the specified tensioning force. Any initial loading exceeding ten percent (10%) shall be approved by the Engineer (i.e. multiple bed casting). The initial load shall be measured within a tolerance of plus or minus one hundred (± 100) lb. The initial elongation measurement shall not be used to determine the initial force.

C. In all stressing operations, the stressing force shall be kept symmetrical about the vertical axis; however, in tensioning single steel strands, the initial and final loads may be applied in immediate succession to each steel strand.

D. Jack mounted pressure gauges shall be the primary system of force measurement for the final tensioning of straight single steel strands. Elongation shall be checked against pressure gauge readings on all steel strands. Slippage shall be checked at steel strand vises. The computed elongation, including operational losses and equivalent elongation for the initial tensioning force, shall agree with the pressure gauge reading within three percent (3%).

E. Jack mounted pressure gauges shall be the primary system of force measurement for the final tensioning of multiple steel strands. For uniform application of load to the steel strands, the position of the face of the anchorage at final load shall be parallel to its position under initial load. Parallel movement shall be verified by measurement of equal movement on opposite anchorage sides and by checking the plumb position of the anchorage before and after final load application. Slippage shall be checked at steel strand vises.

F. After the steel strands are stressed as specified and with all other reinforcement in place, the concrete member shall be cast to the specified lengths. Strand stress shall be maintained between anchorages until the concrete has reached the compressive strength specified in the Contract Documents.

3.13 STEEL STRAND TENSIONING

A. In all methods of tensioning, the stress induced in the steel strands shall be measured both by jacking gauges and by elongation of the steel strands. If any jack or gauge appears to be giving erratic results or gauge pressures and elongations indicate materially different stresses during manufacturing, recalibration will be required. Means shall be provided for measuring the elongation of the steel strands to at least the nearest one eighth inch (1/8″).

B. A difference in indicated stress between jack pressure and elongation of up to five percent (5%) may occur. In this event, the difference shall be placed so that the discrepancy will be on the side of a slight overstress rather than understress. In an apparent discrepancy between gauge pressure and elongation in excess of five percent (5%), the entire operation shall be carefully checked and the source of the discrepancy determined before proceeding further.

C. Split plastic sheathing for debonded steel strands shall be thoroughly sealed with tape prior to placing concrete.

D. All pretensioned steel strands shall be cut flush with the end of the member. Where the end of the member will not be covered by concrete, the exposed ends of the steel strands and the concrete face at the end of the member shall be cleaned and coated with a protective coating as specified in the Contract Documents. Cleaning shall be by wire brushing or abrasive blast cleaning to remove all dirt and residue that is not firmly bonded to the metal or concrete surfaces. Care shall be taken to work the protective coating into all voids in the prestressing steel strands.

3.14 CURING

A. Initial curing of all members shall be accomplished by fogging, wet burlap, or other approved methods and shall begin as soon as the concrete is hardened sufficiently to withstand surface damage. The initial curing shall continue until the concrete has attained its initial set; however, the minimum initial curing period shall be three (3) hours. When a retarding agent is used, the minimum period shall be five (5) hours. Following the initial curing, curing shall be resumed using an accelerated curing method.

B. Accelerated Curing. Accelerated curing of the concrete shall be done by one of the following methods:

1. Low Pressure Steam Curing. Low pressure steam curing shall be done under a suitable enclosure to contain the live steam and minimize moisture and heat loss. The concrete shall be allowed to attain its initial set before application of the live steam. Application of the live steam shall not be directed on the concrete or the forms so as to cause localized high temperatures. The temperature of the interior of the enclosure shall be eighty to one-hundred sixty degrees (80° to 160°) F. During initial application of the steam, the ambient air temperature within the enclosure shall increase at a rate not to exceed forty degrees (40°) F per hour. The maximum temperature shall be held until the concrete has reached the required release strength. The steam temperature and the curing temperature shall be maintained uniformly throughout the extremities of the prestressed member. At the end of curing, the concrete temperature shall be reduced at an average of forty degrees (40°) F per hour.
2. The producer shall furnish at least one (1) recording thermometer for each enclosure. If the enclosure is longer than three hundred feet (300′), an additional recording thermometer shall be furnished for each additional three hundred feet (300′), of length or fraction thereof. The temperature at any point within the enclosure shall not vary more than ten degrees (10°) F from that of the recording thermometer or the average of the recording thermometers if more than one is used.
3. Radiant Heat Curing. Radiant heat may be applied by means of pipes circulating steam, hot oil, or hot water, or by electric heating elements. Radiant heat curing shall be done under a suitable enclosure to contain the heat, and moisture loss shall be minimized by covering all exposed concrete surfaces with a plastic sheeting or applying an approved liquid membrane curing compound to all exposed surfaces. The heat application shall be maintained uniformly throughout the extremities of the member. All temperature constraints shall be the same as outlined for low pressure steam curing.

3.15 DETENSIONING

A. Slab Panels

1. The tension force shall not be transferred to the prestressed slab panel until the concrete strength, as indicated by cylinder strengths, conforms to the specified transfer strength. In control of the prestressed concrete, the compressive strength cylinders shall be used to satisfy two (2) essential control requirements:

a. Concrete in the precast slab panel shall attain the specified strength before the stress in the strands may be transferred.
b. The design strength shall be met before the slab panel may be handled, except to move into storage, or released for shipment.

2. Forms, ties, inserts, hold downs, or other devices that restrict the slab panel's longitudinal movement along the bed shall be removed or loosened prior to detensioning or a method and sequence to minimize longitudinal movement shall be used.
3. Prestressing forces shall be released using a method to minimize sudden or shock loading.
4. Single steel strand detensioning may be accomplished by heat cutting the steel strands. The single steel strand detensioning sequence shall maintain prestressing forces nearly symmetrical around the slab panel's vertical axis. Eccentricity around the vertical axis shall be limited to one (1) steel strand. The steel strand cutting pattern shall be approved by the Engineer prior to its use.
5. Multiple steel strand detensioning may be accomplished by gradually reducing the force applied to each strand equally and simultaneously.

B. Beams

1. The schedule for detensioning of beams having deflected steel strands shall incorporate the following:

   a. The manufacturer's sequence of releasing deflected steel strands and uplift points shall be approved by the Engineer.
   b. All hold down devices for deflected steel strands shall be disengaged and all hold down bolts removed from the beams.
   c. The manufacturer's sequence of releasing the remaining straight steel strands shall be approved by the Engineer.

2. All hold down devices may be released prior to release of tension in deflected steel strands if:

   a. The weight of the prestressed beam is more than twice the total of the forces required to hold the steel strands in the low position.
   b. The weight or other approved vertical restraints are applied directly over the hold down points to counteract the uplifting forces, at least until the release of deflected steel strands has proceeded to a point that the residual uplifting forces are less than half the weight of the beam.

3. All procedures for releasing prestressing forces of deflected steel strands shall be followed carefully. Failure to follow these procedures may result in the rejection of the beams.
4. All beams shall be adequately separated in storage immediately following removal from the bed to facilitate the repair of surface blemishes and to allow inspection of the finished surfaces.

3.16 CAMBER

A. During the beam fabrication period, the Contractor shall select a representative number of beams to be known as "Camber Control Beams", subject to the Engineer's approval. They shall be clearly and permanently identified so that the camber readings taken as indicated below can be associated with the proper beam.

B. Camber readings shall be taken as follows:

1. Just prior to prestressing.
2. Immediately after prestressing.
3. At weekly intervals thereafter within the three (3) months after casting.
4. At biweekly intervals, after the three (3) month period expires.
5. Just prior to shipment from the casting yard to the job site.
6. Camber determinations shall be continued at these intervals if the beams are stored or stockpiled at the job site.

C. Two (2) copies of the camber reports shall be furnished to the Engineer prior to the erection of the beam.

3.17 TOLERANCES

The tolerances for each beam or slab panel shall be as shown in the following Tables C or D, respectively unless otherwise specified in the Contract Documents:

TABLE C

PRESTRESSED CONCRETE BEAM	TOLERANCE
Depth (overall)	± 1/4 inch
Width (flanges & fillets)	± 1/4 inch
Width (web)	± 1/4 inch
Length of Beam	± 1/8 inch per 10 ft or 1/2 inch whichever is greater
Exposed Beam Ends (deviation from square or designated skew)	Horizontal ± 1/4 inch Vertical ± 1/8 inch per ft of beam height
Side Inserts (spacing between center of inserts and from the centers of inserts to the ends of the beams)	± 1/2 inch
Bearing Plate (spacing from the centers of bearing plates to the ends of the beams)	± 1/2 inch
Stirrup Bars: Average of all bars Individual bar longitudinal spacing	± 1/2 inch ± 1 inch
Horizontal Alignment (deviation from a straight line parallel to the center line of beam)	1/8 inch per 10 ft, max
Camber Differential between adjacent beams of same type and steel strand pattern	1/8 inch per 10 ft at time of erection or 1/2 inch max
Center of Gravity of steel strand group	± 1/4 inch
Center of Gravity of depressed group steel strand at end of beam	± 1/2 inch
Position of hold down points for depressed strand	± 6 inch

TABLE D

PRESTRESSED CONCRETE SLAB PANEL	TOLERANCE
Depth (overall)	+1/2 inch –1/4 inch
Width (overall)	± 1/4 inch
Slab Panel Length @ center line (based on design length specified)	± 1/2 inch
Horizontal Alignment (deviation from a straight line parallel to the slab panel center line)	1/4 inch max
Horizontal Misalignment of adjacent form sections	1/2 inch max
Camber Deviation from specified camber, as measured at prestress transfer or at the beginning of slab panel storage at the fabrication plant	± 1/2 inch
Location of each strand	± 1/8 inch
Center of Gravity of strand group	± 1/4 inch
Stirrup Bars (longitudinal spacing)	± 1 inch
Longitudinal Position of handling devices	± 3 inch
Concrete Bearing Area (variation from plane surface when tested with a straightedge through middle half of slab panel	± 1/8 inch
Tie Rod Tubes (spacing between the tube centers and from tube centers to slab panel ends)	± 1/2 inch
Tie Rod Tubes (spacing from tube center to slab panel bottom)	± 3/8 inch
Threaded Inserts (spacing between the center of inserts and from center of inserts to ends of slab panels)	± 1/2 inch
Skew Ends (deviation from designated skew)	± 1/2 inch
Vertical Ends (deviation from specified dimension)	± 3/8 inch

3.18 MARKING, HANDLING, SHIPPING, AND STORAGE

A. Each member shall be marked with an erection mark for identification, weight marks for beams six thousand (6000) lb or more, and inspection stamps. The erection marks on beams shall be painted on the top surface of the top flange. Markings of any kind are prohibited on any surface of a beam that will be visible in the completed structure.

B. Slab panels shall be marked with an individual, consecutive, identification mark at a permanently exposed location. The identification mark shall match that shown on the approved Working Drawings to allow erection as specified in the Contract Documents.

C. The Contractor shall furnish the Engineer with an erection diagram clearly indicating erection marks that show the position of the member in the structure.

D. The cast-in-place lifting devices and a sufficient number of cranes and spreader beams shall be utilized whenever the prestress concrete members are lifted during loading, unloading, storage, erection, etc.

E. The Contractor shall furnish the Engineer copies of material orders and shipping statements. The weight of each individual prestress concrete member shall be shown on the statements.

F. When shipping prestressed concrete members, blocking shall be placed at intervals that will prevent sag and distortion. All members shall be shipped in their upright position and be adequately supported and braced to dampen vibrations during transport as shown on

the Working Drawings. Any member too long to fit inside of a truck or trailer shall not cantilever beyond the bed more than one-quarter of its length. Members too long to comply with this requirement shall be supported on dollies, additional vehicles, or other vehicles that shall support the long pieces as approved by the Engineer.

G. Load restrictions shall be as specified in the Contract Document. Prestressed members shall not be shipped until approved in writing by the Engineer, a minimum of five (5) days have elapsed since the prestressed transfer, and they have attained the minimum twenty-eight (28) day compressive strength.

H. Beams shall be stored off the ground in an upright position, shall be protected as far as practical from surface deterioration, and be kept free of accumulations of dirt, oil, or other deleterious material.

3.18 ERECTION

A. Erection Plan

1. The Contractor shall submit for approval, an erection diagram plan outlining erection procedure of the main members. The plan shall be submitted for approval to the City, a minimum of thirty (30) days prior to beginning erection. This plan shall include the numbers and types of equipment to be used including crane capacity, location of crane for lifting, falsework when required, and main member erection sequence and weight.
2. All wheels and outriggers of a crane or wheels of a structural steel delivery truck shall be at a minimum distance from the rear face of an abutment equal to the vertical distance from the top of a spread footing or to the original ground line if the footing is on piles. No other heavy construction equipment shall be operated within this minimum distance from the rear face of abutments.
3. The Contractor shall erect bridges with continuous main members in a manner providing the proper reactions and avoiding overstressing main members.
4. The Contractor when preparing erection plans and procedures, shall take into account the restrictions imposed by the Maryland Department of the Environment relative to pollution or disturbance of existing waterways in COMAR, Title 26.

B. Falsework

1. The falsework shall be built and maintained in conformance with the approved falsework plans. Any changes subsequent to initial approval which are proposed by the Contractor through the Contractor's professional engineer will be as approved by the Engineer.
2. Before permitting any loads to be placed on falsework, the Engineer shall receive written certification by the Contractor's professional engineer that the falsework system has been assembled in conformance with the approved falsework drawings. This certification shall be accompanied by a Certificate of Compliance stating that all manufactured materials and assemblies fully comply with the falsework design and plans, certificates or invoke all tests required shall be made by the Contractor at no additional cost to the City.
3. In addition to protective measures shown on the falsework plans, the Engineer may direct the Contractor to provide further protection of falsework against accidental collision by highway or construction traffic and equipment, traffic

vibration, flood waters or high winds, etc., that are necessary for public safety and protection of the work.

C. Damaged or Defective Material

The correction of damaged or defective material shall not begin until a written procedure prepared by the Contractor is approved by the City. Correction of damaged or defective material shall be by methods that do not produce fracture or injury. All damaged or defective material will be inspected by the Engineer before and after correction. Corrections shall be conducted in the presence of the Engineer.

D. Assembling Steel

1. Material shall be carefully handled and no parts shall be bent, broken, or otherwise damaged. Bearing surfaces and those to be in permanent contact shall be cleaned before the members are assembled. Before beginning the field bolting and welding, the structure shall be adjusted to correct grade and alignment and the elevations of panel points (ends of floor beams) properly regulated.
2. Splices and field connections shall have half the holes filled using bolts and cylindrical erection pins (forty percent (40%) bolts and ten percent (10%) pins) before torquing high strength bolts. Splices and connections in members carrying traffic during erection shall have three-fourths of the holes filled before torquing. Cylindrical erection pins shall be one-thirty-second of an inch (1/32″) larger than the diameter of the fasteners.

E. Anchor Bolts

1. No anchor bolts shall be cast in the concrete. The Contractor shall create a template to locate the anchor bolt holes. This template shall be used to shift the reinforcement prior to placing the concrete to eliminate conflicts between the reinforcement and the anchor bolt holes.
2. Anchor bolts shall be set in round holes drilled or cast in the concrete. Bolts shall be accurately positioned by using templates set to correct location and alignment to ensure proper span lengths, and tops of bolts shall be carefully set to proper elevation. Unless otherwise noted, bolts shall be installed plumb or normal to the finished bearing surface of the masonry.
3. Bolts set in holes drilled or cast into the concrete shall have the portion below the bridge seat swedged. The drilled or cast holes shall have a diameter at least one inch (1″) larger than the bolt diameter.
4. Anchor bolts, nuts, and washers shall not be painted.
5. After anchor bolts are finally and correctly positioned, the holes shall be completely filled with grout. Grouting of anchor bolts is not permitted until all structural steel is set in its final position. After the masonry plates or shoes are set, the space between the bolts and the round holes through fixed plates or shoes shall be filled with the same material. Slotted holes in expansion devices shall remain unfilled unless otherwise specified in the Contract Documents.
6. The Contractor shall maintain a minimum air temperature of forty degrees (40°) F around the mortar surface for a period of three (3) days unless otherwise recommended by the manufacturer.
7. When mortar filling is used for bolts inserted in holes drilled or cast in the concrete, the holes shall first be checked for depth by inserting and withdrawing the bolts.

They shall then be partially filled with mortar into which the bolts shall be forced by uniform pressure or light blows from a hammer (flogging and running is prohibited) so that excess mortar is pushed out at the top of the hole. The excess mortar shall be removed.

8. Bolts shall be set to project approximately one-half inch (1/2″) above the nut and shall be threaded to approximately one-half inch (1/2″) below the nut in their final position.
9. Rockers or expansion plates with slotted holes shall be set with the proper tilt or offset as determined by the temperature prevailing at the time and so that they will be in their midway position at sixty-eight degrees (68°) F or as specified in the Contract Documents.

F. Maintenance of Concrete. The Contractor shall be responsible for keeping all exposed concrete surfaces free from stains and discoloration. The Contractor shall prevent staining of the finished concrete surfaces where unpainted structural steel is specified. Any stains shall be removed and the concrete restored to its original color.

G. Safety Hazards

1. The Contractor shall be responsible for gas detection in and ventilation of confined spaces.
2. When procedures require workers to enter confined spaces such as concrete box section type superstructures, particularly when the interior is closed off at both ends, the Contractor shall be cognizant of the potential health hazards.
3. The Contractor shall adhere to Maryland Occupational Safety and Health Standard for Confined Spaces - 09.12.35 and all applicable Maryland Standard Methods of Tests: The Contractor shall have approved detecting devices available and shall conduct tests for oxygen content and presence of gases, such as combustible gas, carbon dioxide, methane, carbon monoxide, and hydrogen sulfide whenever any fabrication, erection or inspection operations are to be performed within the confined spaces. The Contractor shall apply mechanical ventilation continuously to the confined space during occupancy to maintain the proper oxygen content and shall conduct air tests periodically during the occupancy.

H. Slab Panels. Immediately prior to erection of slab panels, the abrasive blasted shear key surfaces shall be cleaned with compressed air; stiff bristle fiber brushes, or vacuumed. Slab panels shall be pulled together and field tightened in the transverse direction by tie rods. Field tightening shall be performed with approved impact wrenches. After tightening, all tie rod holes shall be grouted.

I. After field tightening all slab panels, the joint below the shear keys shall be sealed using a method approved by the Engineer. Shear keys shall then be grouted by overfilling the joints. Grout shall be driven or tamped compactly in to the keyways and not vibrated. After a half hour the excess grout shall be struck off flush with the top of the slab panels. The manufacturer's recommendations shall be followed for grouting in cold or hot weather.

3.19 BEARING PADS

A. Bearing pads delivered to the bridge site shall be stored under cover on a platform above the ground surface. Pads shall be protected from damage at all times and shall be kept dry, clean, and free of dirt, oil, grease, and foreign substances.

B. The surfaces of the concrete bearing areas that will be in contact with the bearing pads and the full contact area of the bearing pads shall be coated with epoxy adhesive. The Contractor shall strictly adhere to the manufacturer's recommendations for mixing and applying the epoxy adhesive material. The surface temperatures when applying epoxy adhesive shall be a minimum of fifty degrees (50°) F with a predicted ambient temperature for the next four (4) hours of fifty degrees (50°) F or above. The surfaces to be coated shall be clean, dry, and sound. The Contractor shall be prepared to use water jets, abrasive blasting, air blasting, etc. for cleaning the surfaces to the satisfaction of the Engineer.

C. The bearing pads shall be accurately set in the epoxy adhesive and secured in place by blocking or other mechanical means until the adhesive sets.

PART 4 MEASUREMENT AND PAYMENT

Prestressed concrete members will not be measured but will be paid for at the Contract lump sum price for the pertinent Prestressed Concrete Beams or Prestressed Concrete Slab Panels item. The payment will be full compensation for all concrete, forms, reinforcement, bearing pads, steel strands, sheathing, steel components, steel rods, inserts, grout, bearing pads, epoxy adhesive, testing, furnishing and applying concrete protective coatings when specified, transporting, storage, erection, and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

03 47 00 SITE-CAST CONCRETE

03 47 12 CONCRETE DITCHES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing concrete ditches and incidental toe walls as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Crusher Run Aggregate CR-6. Crusher run aggregate shall conform to 32 11 23.10, (Aggregate Base Course).

B. No. 57 Aggregate. No. 57. Aggregate shall conform to 32 11 23.10, (Aggregate Base Course).

C. Curing Materials. Curing material shall conform to 03 30 00, (Portland Cement Concrete Structures).

D. Form Release Compounds. Form release compounds shall conform to 03 30 00, (Portland Concrete Cement Structures).

E. Concrete Mix No. 2. Concrete Mix No. 2 shall conform to 03 30 00, (Portland Concrete Cement Structures).

F. Joint Sealer. Joint sealer shall conform to 03 30 00, (Portland Concrete Cement Structures).

G. Preformed Joint Filler. Preformed joint filler shall conform to 03 30 00, (Portland Concrete Cement Structures).

H. Borrow. Borrow shall conform to 31 23 16.12, (Borrow Excavation).

I. Soil Stabilization Matting. Soil stabilization matting shall conform to 32 91 16.16, (Soil Stabilization Matting).

PART 3 EXECUTION

3.1 EXCAVATION

Excavation and the preparation of the subgrade shall conform to 32 16 13.13, (Cast-in-Place Concrete Curb and Combination Curb and Gutter). Refer to 31 23 16.16, (Structure Excavation) for excavated material.

3.2 FORMS

Forms shall be steel or wooden and shall conform to 32 13 13.13, (Exposed Aggregate Sidewalk).

3.3 CONCRETE

Concrete mixing and placing shall conform to 32 13 13.13, (Exposed Aggregate Sidewalk).

3.4 JOINTS

Maximum joint spacing shall be fifteen feet (15′). The joints shall be either bulkhead or weakened plane construction joints. Weakened plane joints shall be either tooled or sawed to a minimum depth of three-quarters inch (3/4″). Expansion joints shall be spaced a maximum of ninety feet (90′) and sealed.

3.5 COLD WEATHER CONSTRUCTION AND CURING

Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavement) for cold weather construction and for concrete curing.

3.6 BACKFILL

After the forms have been removed, backfill shall be placed and compacted as directed by the Engineer.

3.7 DITCH REMOVAL

When the existing concrete ditch is removed but not replaced, the area shall be re-graded and stabilized as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all concrete, excavation, forms, backfill, curing, disposal of excess or unsuitable material, toe walls, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Concrete Ditches will be measured and paid for at the Contract Unit Price per square yard.

C. The removal and disposal of unsuitable material below the subgrade will be measured and paid for at the Contract Unit Price per cubic yard for Class 2 Excavation. The payment will include the cost of replacing the unsuitable material with suitable material acceptable to the Engineer, except as specified in D.

D. When Borrow or Selected Backfill using No. 57 aggregate or selected backfill using crusher run aggregate CR-6 is approved by the Engineer as replacement material for the Class 2 excavation, it will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent items as specified in the Contract Documents.

E. Concrete ditches removed but not replaced will be paid for at the Contract Unit Price per square yard. The payment will include the cost to dispose of the material, re-grading, topsoil, and soil stabilization matting.

03 62 00 NON-SHRINK GROUTING

03 62 00.01 NON-SHRINK GROUTING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of drilling holes in existing masonry for grouting of bars, bolts or anchorages, as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Grout: Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of five thousand (5000) psi in seven (7) days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of zero percent (0.0%) after seven (7) days when tested as specified in T 160.

PART 3 EXECUTION

Holes shall be drilled only in the solid portion of the masonry, and are prohibited at points where cracks exist. Drilled holes shall be a minimum of six inches (6″) from the face of any masonry surface. The minimum size of dowel bars shall be No. 6. The holes shall be drilled at least one-half inch (1/2″) larger than the outside diameter of the insert to be

grouted. Holes shall be cleaned and then filled two-thirds full of grout. The insert shall be placed and allowed to set for twenty-four (24) hours.

PART 4 MEASUREMENT AND PAYMENT

A. Drilled Holes in Existing Masonry will be measured and paid for at the Contract Unit Price per linear foot of drilled holes. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Inserts required for insertion in these holes will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

C. Drilled holes for which no specific pay item is included in the Contract Documents will not be measured but the cost will be incidental to the other pertinent items specified in the Contract Documents.

DIVISION 04
MASONRY
04 20 00 UNIT MASONRY

04 20 00.01 REPOINTED MASONRY

PART 1 GENERAL

1.1 DESCRIPTION

This Specification covers the repointing of existing masonry structures with cement mortar.

PART 2 PRODUCTS

2.1 MATERIALS

Mortar: Refer to 04 21 13, Part 2, (Brick Masonry).

PART 3 EXECUTION

The joints in the old masonry shall be cleaned thoroughly of all loose mortar and dirt for a depth of not less than twice the width of the joint and not less than two inches (2″) from the face of the wall. Joints shall then be filled with mortar, well driven in and finished neatly and satisfactorily in conformity with the joints in existing masonry or as otherwise specified. The wall shall be kept wet while pointing is being done and if the weather is hot or dry the pointed masonry shall be protected from the sun and kept wet for a period of at least three (3) days after the mortar is installed. After pointing is completed and the mortar has set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition. For cold weather protection, refer to 03 30 00, Part 3, (Portland Cement Concrete Structures).

PART 4 MEASUREMENT AND PAYMENT

A. This item will not be measured, as it will be paid for on a lump sum basis.

B. This item will be paid for on the basis of the Contract lump sum price for repointed masonry, which payment shall be full compensation for all labor, materials, equipment and incidentals necessary to complete the Work, including curing and hot or cold weather protection.

04 21 00 CLAY UNIT MASONRY

04 21 13 BRICK MASONRY

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of brick laid in full beds of mortar and built to the shapes and dimensions and at the locations specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Compound: Liquid membrane forming compounds shall conform to M 148. Field control testing of the white pigmented curing compounds shall be on the basis of weight per gallon. The samples shall not deviate more than plus or minus three tenths (± 0.3) lb/gal from the original source sample.

B. Brick:

1. Sewer brick shall have a standard size of two and one quarter inches by three and three quarter inches by eight inches (2-1/4″ X 3-3/4″ X 8″) and conform to M 91, Grade SS.
2. Manhole brick shall conform to M 91, Grade MS.
3. Building brick shall conform to M 114, Grade SW.
4. Hollow load bearing concrete masonry block shall conform to C 90, Grade N, Type I, normal weight.
5. Solid concrete masonry block shall conform to C 145. Grade S, Type I and II, except units exposed to weather shall be Grade N, Type I or II.

C. Mortar used for masonry shall be composed in conformance with one of the following:

1. One (1) part Portland or blended cement and three (3) parts mortar sand by dry loose volume and hydrated lime not to exceed twenty percent (20%) of the cement by weight.
2. One (1) part masonry cement and three (3) parts mortar sand by dry loose volume.
3. Prepared bag mixes consisting of masonry cement and mortar sand. The prepared mixes shall produce a minimum compressive strength of five hundred (500) psi in seven (7) days when tested using the applicable procedures specified in C 91.
4. Materials for mortar shall conform to the following:

   a. Mortar Sand shall conform to the following tables.

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

MATERIAL	SIEVE SIZE			
	No. 4	No. 8	No. 100	No. 200
FINE AGGREGATE/SAND MORTAR and EPOXIES (d)	100	95–100	0–25	0–10

TABLE B – AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

MATERIAL TYPE I	SPECIFICATION	TEST METHOD T 104 SODIUM SULFATE SOUNDNESS % max	T 112 CLAY LUMPS & FRIABLE PARTICLES % max	T 113 COAL & LIGNITE % max	T 21 ORGANIC IMPURITIES max
FINE AGGREGATE/SAND MORTAR & EPOXIES	M 45	10	1.0	0.5	3.0

b. Portland Cement: Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 131 and T 153, respectively.

c. Blended Cement: Blended hydraulic cement shall conform to M 240, Type I (PM) or a Type IP containing fifteen percent to twenty-five percent (15% to 25%) pozzolan by weight of cement. Maximum loss on ignition shall be three percent (3%) and ground iron blast furnace slag shall not be used for blending. The requirement for a manufacturer's written statement of the chemical composition is waived.

d. Masonry Cement: Masonry cement shall conform to C 91, except the water retention and staining tests are waived.

e. Water: Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of Portland cement concrete shall be determined in conformance with D 512 and shall not exceed one thousand (1000) ppm limit.

f. Lime: Hydrated lime shall conform to the chemical requirements of C 206, Type N when used in finishing or C 207, Type N when used for masonry.

g. Hydrated lime for soil stabilization shall have a minimum combined calcium oxide and magnesium oxide content of sixty-five percent (65%) when tested as specified in C 25 and shall conform to the following gradation:

SIEVE SIZE	PERCENT RETAINED max
3/8 inch	0
No. 30	3
No. 200	25

5. Quicklime shall have a combined calcium oxide and magnesium oxide content of seventy-five percent (75%) minimum and a gradation of one hundred percent (100%) passing the three-eighths inch (3/8") sieve when tested as specified in C 25.

D. Fusion Bonded Epoxy Powdered Coatings:

1. The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the prequalified materials list from the Engineer.
2. Epoxy coatings shall conform to D 3963.
3. Material used for the touch-up system shall be a two (2) part epoxy system designated and color matched for patching the epoxy coating used. Patching material shall be available through the manufacturer of the epoxy powder. The

patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.

4. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

E. Water: Water shall be as per aforementioned paragraph 2.1 C e.

F. Dove Tail Anchors shall be as specified in the Contract Documents.

2.2 SAMPLE PANEL

When specified in the Contract Documents, a sample panel measuring a minimum of twenty-four inches by twenty-four inches (24″ X 24″) shall be prepared and delivered to the construction site. The panel shall be typical of the brickwork to be used on the project. The City's approval of the panel shall be received before beginning the brickwork on the project. The sample panel shall remain on the project site and all subsequent brickwork shall be equal in appearance to this approved panel.

PART 3 EXECUTION

3.1 CONSTRUCTION

A. Unless otherwise specified, all brick masonry shall be laid in level courses with faces plumb, square and true to the dimensions specified. All exposed surfaces shall be smooth. Brick masonry for parapets and end posts shall be laid parallel to the roadway or barrier.

B. Brick facing shall be constructed as specified in the Contract Documents.

C. Masonry Work for Utility Structures:

1. Use sewer brick whenever brick construction is exposed to flow; otherwise, use manhole brick or solid concrete block. Lay sewer brick on edge so that the two and one quarter inch by eight inch (2-1/4″ X 8″) side is exposed to flow.
2. Lay manhole brick so that every sixth brick course is a header course. Lay the first course of concrete masonry units in a full bed of mortar for the full width of the unit. Lay succeeding courses with broken joints. Form bed-joints by applying the mortar to the entire top surface of the inner and outer face shells. Form head joints by applying the mortar for a width of about 1 inch (1″) to the ends of the adjoining units laid previously. The mortar for the joints shall be smooth, not furrowed, and shall be of such thickness that it will be forced out of the joints as the units are being placed in position. Where anchors, bolts, and ties occur within the cells of the units, fill such cells with mortar or grout as the Work progresses. Use concrete brick for bonding walls, working out the coursing, topping out walls under sloping slabs, distributing concentrated, backing brick headers, and elsewhere as required.
3. Where practicable, lay each course with a line. For courses curved or in nonparallel planes, use bonded and keyed brick construction. Joint thickness shall not be less than one-quarter inch (1/4″) nor more than one half inch (1/2″). For courses curved or in non-parallel planes, make the thickest part of the joint as thin as practicable.

4. Rack or tooth uncompleted brick and block construction and parge non-exposed surfaces with one-half inch (1/2″) of mortar. Tool concave in a manner that will compact and press mortar against units all joints except where Work will be parged.

3.2 BOND

Unless otherwise specified, brick masonry shall be laid in running bond. Adjoining courses shall be laid to break joints by half brick as nearly as practical.

3.3 BRICKLAYING

All brick shall be sprayed with water to dampen the surface prior to laying. Only fresh plastic mortar shall be used, and it shall be soft and workable when placed on the wall. A layer of mortar shall be spread on the beds and not more than a shallow furrow which can be readily closed by the laying of the brick shall be made in it. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made so that mortar is squeezed out at the top of the joint. No brick shall be jarred or moved after it has been fully bedded in the mortar. Bricks loosened after the mortar has taken its set shall be removed, cleaned, and re-laid with fresh mortar. No broken or chipped brick shall be used in the face. Spalls or bats are not permitted except where necessary to shape around irregular openings or edges. Full bricks shall be placed at ends or corners where possible and the bats used in the interior of the course. In making closures, bricks shorter than the width of a whole brick shall not be used. Whole brick shall be used as headers.

3.4 JOINTS

All joints shall be slushed with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces in contact with the earth shall be back plastered or parged with two (2) coats of mortar each not less than three-eighths inch (3/8″) thick before the backing is laid up. The first coat shall be cross-scratched; the second coat shall be troweled smooth, beveled at the top and covered out at the edge of the footing. Extend parging not more than four inches (4″) above grade, unless indicated otherwise, and keep damp for at least three (3) days. Prior to parging, all joints on the back of face courses shall be cut flush. Joints shall be one-quarter inch to one-half inch (1/4″ to 1/2″) wide. Whatever width is adopted shall be maintained uniformly throughout the Work.

3.5 POINTING

All exterior head and bed joints shall be tooled with a round tool, slightly larger than the joint, pressed tight against the still plastic mortar so as to provide a concave finish. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed as soon as the nail or pin is removed.

3.6 CLEANING

Upon completion of the Work, all exterior surfaces shall be cleaned by scrubbing and washing down with water, or if necessary, cleaning shall be done with a five percent (5%) solution of muriatic acid, which shall then be rinsed off with liberal quantities of clean fresh water.

3.7 CURING

A. After the Work has been laid up and pointed, the exposed surfaces of brick masonry shall be cured by one of the following methods:

1. Brick shall be covered with two (2) layers of burlap and kept wet for three (3) days.
2. A non-asphalt colorless liquid curing compound shall be applied by means of an approved hand or motor-driven spray operated at a pressure between forty (40) and sixty (60) psi. The liquid compound shall be uniformly applied at a rate of twenty-seven (27) yd^2/gal. The material shall be applied so that the exposed surface is completely coated and sealed in one application. At points where the Work shows evidence of insufficient coating, additional material shall be added as directed by the Engineer.

3.8 COLD WEATHER PROTECTION

Brick Masonry Work and pointing are not permitted when there is frost in the brick or when the air temperature is below fifty degrees (50°) F, unless the Contractor provides suitable housing, covering and tarpaulins, and heating devices necessary to keep the atmosphere surrounding the masonry at a minimum temperature of fifty degrees (50°) F for the curing period.

3.9 BACKFILL

Brick masonry shall not be backfilled before seven (7) days after completion of the section.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all sample panels, dovetail anchors, curing and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Brick Masonry for Structures will be measured and paid for at the Contract Unit Price per square foot.

C. Brick Masonry for Structures will be measured and paid for at the Contract Unit Price per cubic yard.

D. Brick Masonry for Structures will not be measured but will be paid for at the Contract lump sum price.

E. Brick Masonry Facing will be measured and paid for at the Contract Unit Price per square foot.

F. Brick Masonry Facing will be measured and paid for at the Contract lump sum price.

04 43 00 STONE MASONRY
04 43 00.01 GENERAL REQUIREMENTS FOR STONE MASONRY

PART 1 GENERAL

The Specifications under this article cover the general requirements for construction procedure for stone masonry.

PART 2 PRODUCTS

2.1 MATERIALS

Refer to the Materials Section of the particular masonry item.

PART 3 EXECUTION

3.1 GENERAL

A. All stone masonry shall be constructed by experienced and skilled workmen.

B. Stone masonry shall be constructed on an approved foundation and bedding planes shall be shaped and constructed to resist both sliding and overturning.

C. Stone shall be kept clean and free from oil, dirt and any other injurious and foreign material, which might prevent the proper adhesion of the mortar or detract from the appearance of the exposed faces.

D. Stone shall be delivered in such quantities and sufficiently ahead of the time when it will be needed in the structure so as to insure that the masons, will at all times, have on hand an adequate supply from which to make a satisfactory selection.

E. Suitable stone from excavation areas within the limits of the highway and meeting the requirements for the stone specified may be saved and stockpiled within the limits of the roadway, when approved by the Engineer.

F. Quarry sites, when opened by the Contractor, shall not be operated within clear view of the roadway except where widening of roadway cuts is authorized in writing by the Engineer.

3.2 SAMPLE WALL

A. The appearance of the finished stonework shall correspond to the intent of the drawings. When specified, the Contractor shall build, at a location designated by the Engineer, an 'L' shaped sample section of wall not less than five feet (5′) high and at least eight feet (8′) long showing examples of face, ends and top of wall; the method turning corners and of forming joints, all of which shall be subject to the approval of the Engineer. No masonry shall be laid prior to the approval of such sample wall.

B. The location of the wall shall be selected so as to make it most readily visible to the masons laying stone in the structure. In selecting and laying stone, the Specifications shall be followed but it is to be noted that the sample wall, as approved, will also govern to a large extent the method by which the stone is laid.

C. Upon completion and acceptance of the Work, the sample wall shall be removed and disposed of in its entirety and no measurement or payment will be made for its construction or removal and disposal.

3.3 DIMENSIONS OF STONE

A. For the purpose of the Specification the terms used to identify the dimensions of the stone are defined as follows:

1. Height: The vertical dimensions perpendicular to the natural bed of the stone or normally the thickness of course.
2. Width: The shorter dimension of the bed plane or normally the distance the stone extends into the structure.
3. Length: The longer dimension of the bed plane or normally the horizontal dimension of the stone along the face of the structure.
4. Individual stones shall be of size stipulated under materials. No stones except headers shall have a length less than one and one-half (1-1/2) times their width. The thickness of courses and the height of individual stones, if varied, shall diminish regularly from bottom to top of structure.

3.4 HEADERS

Headers shall be laid with their long dimension perpendicular to the exposed face and shall hold in the heart of the structure the same size shown on the face. The exposed faces shall occupy not less than one fifth (1/5) of the face area of the wall and they shall be evenly distributed. Headers in masonry two feet (2′) or less in thickness shall extend entirely through same. Where stone facing is used, the header shall extend into the structure and shall almost reach the surface to be faced. Headers in face and rear of structure or in opposite faces, shall interlock.

3.5 SURFACE FINISHES OF STONE

Unless otherwise specified, all stone used in masonry Work as contemplated by this Specification shall have for its showing face, a rock face and unless further specified the rock face shall not exceed two inches (2″) from the pitch line.

3.6 DRESSING STONE

All dressing and shaping of stone shall be done before the stone is laid and no dressing or hammering will be permitted after it is placed. Hollow beds will not be permitted. Portions of stones exposed in the finished structure shall have seam face removed and rock face showing.

3.7 LAYING STONE

A. The bottom stone in foundation courses shall be composed of the larger, selected flat bed stone. The larger stones shall be used in the lower portions of the structure and stone shall be graded to the smaller sizes toward the top. At least ninety percent (90%) of all stones shall be laid on their natural beds. Each stone shall be cleaned before being set in the bed which is to receive it. All stone shall be well bedded in an ample thickness of freshly made mortar and so placed as to break joints and form a firm bond. All joints shall

be completely filled with mortar and the stone shall be carefully settled in place before the mortar has set. No spalls will be permitted in the beds nor in the face of the wall.

B. Stone shall be handled in such manner so as not to jar or displace masonry already set. Rolling or turning stones after placing will not be permitted. If any stone is loosened after the mortar joint has set, it shall be removed, the mortar cleaned off and the stone re-laid, using fresh mortar. Hand- or power-operated derricks shall be provided for setting stones weighing more than two hundred (200) pounds and such stones shall be handled by means of clamps, lewis pins or tongs, which do not foul the beds or joints. Drill holds for stone hocks will not be permitted to show in completed faces.

C. Each course shall be completed or leveled up for its full width at any particular location before a succeeding course is placed upon it. Cross beds for plumb faces shall be level and for battered walls the cross beds may vary from level to normal to the batter of the front face.

D. No bunching of small stones or stones of the same size will be permitted. Weathered or colored stones or stones of varying texture shall be uniformly distributed over the exposed face of the Work. There shall be a variety in the size, color and texture of the face stones, unless uniformity is specified.

E. In no case shall a vertical joint be located so as to occur directly above or below a header. In no case shall corners of four (4) stones be adjacent to each other at a common joint. Vertical joints shall not be more than forty-five degrees (45°) out of plumb nor shall they extend in an unbroken line through more than two (2) stones. Beds shall not extend in an unbroken line through more than five (5) stones. Tops of top courses or copings shall be pitched to drain.

F. Backing shall consist of large stones, well shaped and laid so as to break joints and provide a firm bond. All spaces between the stones shall be flushed with mortar. No voids shall be permitted in any part of the wall. Spalls may be used between the larger stones and the backing. Except on facing Work, the rear face of backing shall present an approximately plane surface.

3.8 JOINTS

The type and size of joint shall be as indicated on the Plans and the thickness of joint or bed shall be uniform throughout.

3.9 POINTING

A. Whenever possible, the face joints shall be properly pointed before the mortar becomes set. Joints, which cannot be so pointed, shall be prepared for pointing by raking them out to a depth of two inches (2″) before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing.

B. Joints not pointed at the time stone is laid shall be thoroughly wet with water and filled with mortar. The mortar shall be well driven into the joints with a “set-in” or caulking tool and finished with an approved pointing tool. Mortar in top of joints of top surfaces shall be crowned to drain. The wall shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least three (3) days after completion.

3.10 CLEANING SURFACES

Immediately after the masonry and pointing have been completed and the joints have taken final set, all exposed surfaces shall be cleaned and kept free from loose mortar and cement stains. Before completion of the Contract, the masonry shall receive a final cleaning by means of wire brushes and water. If directed by the Engineer, cleaning shall be done using a five percent (5%) solution of muriatic acid, which shall then be rinsed off with liberal quantities of clean fresh water.

3.11 DRAINAGE

A. Backfill behind cement rubble masonry retaining walls and abutments, more than 15 feet long, shall be drained by means of weep holes spaced not more than 10 feet apart and placed 6 inches above the lowest elevations from which free outlets are available. Weep holes shall be formed of four inch (4″) diameter clay pipe of the type specified for underdrain outlets, 33 46 16.19, (Pipe Underdrains and Outlets). The pipes shall be built in the wall on a slope of one-half inch (1/2″) per foot. They shall project three inches (3″) beyond the front face of the wall and be covered at the back face of the wall with not less than two (2) cubic feet of loose stone or spalls, all of which would pass a screen having one and one-half inches (1-1/2″) square openings. All pipe joints shall be fully sealed with mortar.

B. Weep holes and stone drains will not be measured or paid for as such nor will any deduction be made from masonry quantities for the volume occupied by the pipe, but all costs in connection with these items shall be included in the price bid for the masonry.

3.12 CURING AND COLD WEATHER PROTECTION

A. All surfaces of cement stone masonry shall be covered with burlap and kept wet for a period of at least three (3) days after completion of any portion. No cement stone masonry Work or pointing shall be done on any part of a structure when there is frost in the stone or when the air temperature is below fifty degrees (50°) F or at any time between November 15 and April 15, unless the Contractor has been directed by the Engineer and has suitable housing, covering tarpaulins, etc. Also, the Contractor shall have artificial heating devices which will be necessary to keep the atmosphere surrounding the masonry at a temperature of not less than sixty degrees (60°) F for the curing period.

B. Where stone facing over a concrete structure is used, the stone facing shall be cured by being covered with burlap and kept continuously wet for a period of three (3) days after the completion of any portion. The concrete shall be cured in accordance with the applicable provisions of 03 30 00, Part 3, (Portland Cement Concrete Structures). Both stone facing and concrete shall be protected during cold weather in accordance with the provisions of 03 30 00, Part 3, (Portland Cement Concrete Structures).

3.13 BACKFILLING

A. Backfilling shall not be placed against any cement rubble masonry unit until it is seven (7) days old between April 15 and November 15 and not until it is fourteen (14) days old at any other time.

B. Where stone facing over a concrete structure is used, refilling or backfilling against the structure may be done after all provisions for curing, etc. have been complied with and

when compression test specimens indicate that the concrete has attained a minimum compressive strength of three thousand (3000) psi.

PART 4 MEASUREMENT AND PAYMENT

Stone masonry shall be measured and paid for as described for the particular class of masonry specified.

04 43 00.02 CLASS "A" CEMENT RUBBLE MASONRY AND CLASS "A" CEMENT RUBBLE MASONRY FACING

PART 1 GENERAL

1.1 DESCRIPTION

A. This item covers classes of masonry commonly known as coursed, random and random range Work composed of roughly squared and dressed stone laid in cement mortar.

B. When the structure is composed entirely of stone this item shall be known as "Class 'A' Cement Rubble Masonry" and when the structure is faced with stone it shall be known as "Class 'A' Cement Rubble Masonry Facing."

PART 2 PRODUCTS

2.1 MATERIALS

A. Stones: The stone shall be quarried. They shall be clean, hard, durable, and free from cracks, rifts, laminations and any structural defects, which would impair their strength or lessen durability. The stones shall also be free from rounded or weathered surfaces. As a general rule, the type of stone as well as the quarry where it is to be obtained will be specified for a Contract. If the kind of stone is not specified, the Contractor shall submit the name of the stone and quarry for the Engineer's review and approval.

1. Minimum size of individual stone shall be as follows:

   a. Thickness (height of course) = six inches (6″)
   b. Width (horizontal distance extending into structure) = one and one-half (1-1/2) times the thickness
   c. Length (horizontal distance along face of structure) = one and one-half (1-1/2) times the width
   d. Except that in not more than twenty percent (20%) of stones in any face of a structure the minimum thickness may be four inches (4″).

2. Where the structure or unit of structure is composed entirely of stone masonry (not stone faced) header stones shall have their width at least twice the thickness and in some cases must extend entirely through the structure.

3. Note that the sizes of stones noted above are minimum and by submitting a bid, the Contractor agrees to grade the actual stones furnished from aforesaid minimums up to larger sizes as specified by the requirements of the Engineer.

4. Also note that a sample wall, which is usually required prior to construction of stone masonry and the approval thereof, may govern the selection of the larger stones, which will be accepted in the final product.

5. Furthermore, for stone masonry facing, the quarry is warned not to furnish stones with widths in excess of the facing or veneer dimensions and not more than ten percent (10%) of the stone shall be the same size. Unless otherwise specified, the stone shall have a rock face not exceeding two inches (2″).

B. Mortar: Refer to 04 21 13, Part 2, (Brick Masonry).

C. Weep Holes: Refer to 03 30 00, Part 2, (Portland Cement Concrete Structures).

D. Burlap: Burlap cloth shall be made from jute or kenaf and conform to M 182, Class 1, 2 or 3.

PART 3 EXECUTION

3.1 GENERAL

This Work shall be done in accordance with all of the applicable provisions of 04 43 00.01, (Stone Masonry), "General Requirements for Stone Masonry," which is hereby made part of the Specifications for this item and a sample wall as described therein will be required.

3.2 SIZE OF STONES,

Refer to Part 2.1, Materials.

3.3 DRESSING STONE

Individual stones shall be satisfactory to the Engineer and shall be roughly squared on joints, beds and faces. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls. If specified, all corners or angles in exterior surfaces shall be finished with a chisel draft.

3.4 LAYING STONE

A. Stone shall be set in random bond (or as specified) so as to produce the effect indicated on the Plans and to correspond to the approved sample wall.

B. Unless otherwise shown or directed, horizontal joints in the face of the structure shall be eye level. Not more than ten percent (10%) of the vertical joints shall be inclined. Thickness or width of beds and joints shall not exceed two inches (2″) nor be less than one-half inch (1/2″) and the width that is adopted shall be maintained uniform throughout. If varying widths are permitted, their size shall diminish regularly from bottom to top of the structure. Mortar in face shall be finished at the specified depth back of the face of the stone and the size and finish of joints shall be maintained as specified and as approved in the sample wall. In no case shall mortar in the face joints be flush with the surface of the stone.

3.5 STONE FACING DETAILS

A. The following additional requirements are applicable to stone-faced structures. Stone-faced structures may be constructed by either of the methods described below and unless otherwise noted the choice of method is optional with the Contractor, with the details of procedure being subject to the approval of the Engineer.

B. Unless otherwise indicated on the Plans or in the Special Provisions the stone facing item will include all Work in front of theoretical planes of demarcation located one foot (1′) behind and parallel to the planes of the principal faces of the structure as dimensioned, excluding ornamental details, pilasters, copings, etc. All devices for anchoring the facing to the structure are considered to be included in the facing item. All Work behind the theoretical plane of demarcation shall be considered as included in items other than the stone facing.

3.6 METHOD A

A. This method of construction embraces stone masonry facing which is laid up in advance of the construction of the balance of the structure and is then used as a front form behind and against which concrete is poured to comprise the main structural units.

B. Such stone facing shall be constructed not more than one (1) stone thick and in lifts not more than four feet (4′) high. In order to improve the bond between the stone facing and the concrete backing, the back face of the stone masonry shall be made as irregular as possible by using stone of varying widths. Projecting ends of headers or other wide stones shall be temporarily supported by being blocked up with stone until the mortar has hardened sufficiently to hold them in place and the blocking may be removed.

C. The concrete backing shall not be placed against the stone masonry until at least twenty-four (24) hours after the stone masonry is laid up and until the mortar has set sufficiently to insure that the stone or masonry will withstand the pressure of the concrete without damage or displacement. All stone masonry joints and surfaces against which concrete is to be placed shall first be carefully cleaned using wire brushes, picks and scrapers, if necessary to remove all loose material and they shall then be rinsed with clean water prior to placing the concrete. Concrete shall be placed in lifts not more than four feet (4′) high, each of which shall be allowed to set at least twenty-four (24) hours before a succeeding lift is placed upon it. Concrete shall be placed and vibrated in accordance with the provisions of 03 30 00, (Portland Cement Concrete Structures). The Contractor shall be solely responsible for any damage to the stone masonry or concrete resulting from this method of operation, even though the procedure has been approved by the Engineer and any stone masonry or concrete which may become displaced or misaligned shall be removed and replaced at the Contractor's expense.

D. The stone facing shall be positively anchored to the concrete backing by means of metal anchors spaced not more than two feet (2′) apart both horizontally and vertically. Anchors shall be subject to approval by the Engineer before being used and shall be of a type, which may be installed without requiring any increase in the thickness of the joints. Unless otherwise specified or approved, they shall be one-half inch (1/2″) round deformed reinforcing steel bars bent in the shape of an elongated letter "S". They shall be embedded in the mortar of horizontal joints so that the end nearest the face of the wall will be two inches (2″) back of the surface of the mortar in the joint. The length of the anchors

shall be such that they will extend into the concrete backing a distance of six inches (6″) beyond the theoretical plane of demarcation between facing and backing.

E. Back forms shall be anchored to the stone facing by approved types of form ties secured in the masonry facing in a manner acceptable to the Engineer.

3.7 METHOD B

A. This method of construction embraces stone masonry facing which is laid up and applied as a veneer on a previously constructed concrete structure.

B. Work on the stone masonry shall not be started until after the portion of the structure to be faced has been cured. The thickness of individual stones in the facing shall be as nearly as possible, equal to the full thickness specified for the facing. Any spaces remaining between the facing stone and the structure shall be completely filled with mortar in which spalls may be embedded. The surface of the structure concrete shall be kept moistened as the facing is being applied.

C. The stone masonry facing or veneer shall be positively anchored to the concrete structure by means of metal anchors spaced not more than two feet (2′) apart both horizontally and vertically. Anchors shall be subject to the approval of the Engineer before being used and shall be of a type, which may be installed without requiring any increase in the thickness of the joints. All anchor devices for this type of construction shall be galvanized by the hot-dip method. When dovetail anchors and anchor slots are used, adequate provisions shall be made to keep the slots from becoming clogged with concrete or mortar during the construction of the concrete structure. Slots shall be installed vertically in the concrete structure, tight against the forms, and if necessary, they shall be temporarily filled with a removable filler to keep out mortar and concrete. When stone is being laid, the temporary slot filler shall be removed. The slots shall be completely filled with mortar and the dovetail anchors shall be installed in the slots and bedded in mortar throughout.

PART 4 MEASUREMENT AND PAYMENT

A. This item will be measured by one of the methods described below, depending on the stipulations of the Plans or Special Provisions or the method indicated by the Proposal.

B. Pre-cast architectural stone or concrete shall be included in the quantities along with the other stone when measured by any of the following methods unless otherwise noted on the Plans or in the Special Provisions and provided for in the Proposal.

C. Deductions from volume or surface measurements will be made for all openings except those specifically excluded.

1. The item of “Class ‘A’ Cement Rubble Masonry” or “Class ‘A’ Cement Rubble Masonry Facing” will not be measured but is to be completed in its entirety as specified and as shown on the Plans.
2. The item of “Class ‘A’ Cement Rubble Masonry” will be measured on the basis of the volume of the Work satisfactorily completed and accepted, including copings, determined from measurements made by weighing the material and such weights will be converted to cubic yards for payment purpose. The Engineer will determine factors for conversion from weight measurement to volume measurement. These

conversion factors shall be agreed upon by the Contractor and the Engineer, prior to the approval of pay quantities by the Engineer.

3. The item of "Class 'A' Cement Rubble Masonry Facing" will be measured on the basis of the exterior surface area of the facing as projected on planes parallel to the principal surfaces. This will exclude from the surface measurements such items as the tops of walls, copings and bridge seats, faces of ornamentation which do not show when projected on planes parallel to the principal surfaces, ends of stones at corners, except that where masonry facing continues around a corner for more than the length of one (1) stone. This surface shall be projected on a new plane and measured.

D. Sample walls will not be measured for payment.

E. This item will be paid for on the basis of one of the following methods as indicated in the Special Provisions or Proposal.

1. The Contract lump sum price for "Class 'A' Cement Rubble Masonry" or "Class 'A' Cement Rubble Masonry Facing."
2. The Contract Unit Price for cubic yard for "Class 'A' Cement Rubble Masonry."
2. The Contract Unit Price per square foot for "Class 'A' Cement Rubble Masonry Facing."

a. Payment on the basis of any of these methods for Work measured as described above shall be full compensation for all labor, materials, equipment and incidentals necessary to satisfactorily complete the item as specified, including anchors, cramps, dowels, etc., the sample wall, weep holes and any pre-cast architectural stone or concrete for which no other basis of payment is provided.

04 43 00.03 CLASS "B" CEMENT RUBBLE MASONRY

PART 1 GENERAL

1.1 DESCRIPTION

This Specification covers coursed or uncoursed masonry composed of roughly squared stones laid in cement mortar, as indicated on the Plans.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stones: The stones shall be quarried. They shall be clean, hard, durable, and free from cracks, rifts, laminations and any structural defects, which would impair their strength or lessen durability. The stones shall also be free from rounded or weathered surfaces. As a general rule, the type of stone as well as the quarry where it is to be obtained will be specified in a Contract. If the kind of stone is not specified, the Contractor shall submit the name of the stone and quarry for the Engineer's review and approval.

1. Minimum size of individual stone shall be as follows:

   a. Thickness (height of course) = six inches (6″)
   b. Width (horizontal distance extending into structure) = one and one-half (1-1/2) times the thickness
   c. Length (horizontal distance along face of structure) = one and one-half (1-1/2) times the width
   d. Except that in not more than twenty percent (20%) of stones in any face of a structure the minimum thickness may be four inches (4″).

2. Where the structure or unit of structure is composed entirely of stone masonry (not stone faced) header stones shall have their width at least twice the thickness and in some cases must extend entirely through the structure.

3. Note that the sizes of stones noted above are minimum and by submitting a bid, the Contractor agrees to grade the actual stones furnished from aforesaid minimums up to larger sizes as required by the Engineer.

4. Also note, that a sample wall, which is usually required prior to construction of stone masonry and the approval thereof, may govern the selection of the larger stones which will be accepted in the final product.

5. Furthermore, for stone masonry facing, the quarry is warned not to furnish stones with widths in excess of the facing or veneer dimension and not more than 10% of the stone shall be of the same size. Unless otherwise specified the stone shall have a rock face not exceeding two inches (2″).

B. Mortar: Refer to 04 21 13, Part 2, (Brick Masonry).

C. Weep Holes: Refer to 03 30 00, Part 2, (Portland Cement Concrete Structures).

D. Burlap: Burlap cloth shall be made from jute or kenaf and conform to M 182, Class 1, 2 or 3.

PART 3 EXECUTION

3.1 GENERAL

This Work shall be done in accordance with all of the applicable provisions of 04 43 00.01, (General Requirements for Stone Masonry), which is hereby made part of the Specifications for this item. Unless specifically required by the Special Provisions, a sample wall will not be required.

3.2 SIZE OF STONE

At least ninety percent (90%) of the face area of the structure shall be composed of individual stones having exposed dimensions greater than five inches (5″) in height and eight inches (8″) in length. No stone shall have a width less than one and one-half (1-1/2) times its height nor a length less than one and one-half (1-1/2) times its width.

3.3 DRESSING STONE

No trimming or shaping of wall stones will be required except to obtain a face varying not more than one and one-half inches (1-1/2″) from a true plane and to form beds and joints of sound masonry.

3.4 LAYING STONE

A. Stones of various sizes shall be uniformly distributed throughout the face, care being taken to eliminate the bunching of either small stones or stones of the same size. Spalls will not be permitted in the face of the structure. Selected stones roughly pitched to line shall be used at all angles and ends of walls.

B. In general, bed surfaces shall be practically perpendicular to the face of the stones for at least four inches (4″) from which point back they may be irregular. Bed surfaces shall be free from depressions or projections that might impair the strength of the stone or prevent full bearing in the mortar.

C. The backing or interior of the structure shall be constructed so that the stones of which it is composed will be well bonded to the face stones and to each other and laid in full beds of mortar. All spaces and interstices shall be completely filled with mortar and spalls.

3.5 JOINTS

Thickness or width of beds and joints shall be not less than one-half inch (1/2″) nor more than two and one-half inches (2-1/2″). Joints not pointed when the stone is laid shall be raked out carefully to a depth of one inch (1″) back of their finished face and pointed later. Mortar in joints may be finished flush with the stone or at the specified depth back of the face.

3.6 POINTING

All exterior head and bed joints shall be tooled with a round tool, slightly larger than the joint, pressed tight against the still plastic mortar so as to provide a concave finish. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed as soon as the nail or pin is removed.

3.7 CLEANING

Upon completion of the Work, all exterior surfaces shall be cleaned by scrubbing and washing down with water, or if necessary, cleaning shall be done with a five percent (5%) solution of muriatic acid, which shall then be rinsed off with liberal quantities of clean fresh water.

3.8 CURING

After the Work has been laid up and pointed, the exposed surfaces of rubble masonry shall be cured by being covered with two (2) layers of burlap and kept wet for three (3) days.

3.9 BACKFILLING

Rubble masonry shall not be backfilled before seven (7) days after completion of the section.

PART 4 MEASUREMENT AND PAYMENT

A. This item, according to the requirements of the Plans, or Special Provisions or the method indicated in the Proposal, will either not be measured or will be measured on the basis of the volume of the Work satisfactorily completed and accepted, including copings, determined from measurements made by weighing the material and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of pay quantities will be approved by the Engineer.

B. This item will be paid for as indicated in the Proposal, either on the basis of the Contract lump sum price or the Contract Unit Price per cubic yard for "Class 'B' Cement Rubble Masonry" measured as described above, which price and payment shall be full compensation for all labor, materials and incidentals necessary to satisfactorily complete the Work as specified, including any weep holes, special copings or architectural cast stone which may be required.

04 43 00.04 DRY RUBBLE MASONRY

PART 1 GENERAL

1.1 DESCRIPTION

Dry Rubble Masonry shall consist of roughly squared and dressed, approved rubble stone laid without the aid of mortar, so as to fit neatly and firmly together and it shall be constructed to the shapes and dimensions and at the locations as indicated on the plans or as directed in accordance with these Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

All stones for this Work shall be rubble stone of the quality and size specified under Cement Rubble Masonry and of shapes which will permit the use of horizontal beds and approximately vertical joints. Stones smaller than specified may be used for pinning and filling interstices in the heart of the wall.

PART 3 EXECUTION

3.1 GENERAL

This Work shall be done in accordance with all of the applicable provisions of 04 43 00.01, (General Requirements for Stone Masonry) which is hereby made part of the Specification for this item.

3.2 SIZE OF STONES

Stone shall be of a size meeting the requirements outlined in 04 43 00.03, Part 2, (Class 'B' Cement Rubble Masonry). Foundation courses shall be constructed of large stone not less than twelve inches (12″) in height and containing not more than six (6) square feet of bed area.

3.3 DRESSING STONE

Stones shall be roughly squared on joints, beds and faces. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls.

3.4 LAYING STONE

A. All stone shall be laid to line, at least ninety percent (90%) of them on their natural beds, in irregular courses roughly leveled up and so that vertical joints break by at least six inches (6″) Headers shall be used as provided for in 04 43 00.01, Part 3, (General Requirements for Stone Masonry). Thickness of courses and height of individual stones shall diminish regularly from bottom to top of structure. Stone shall be laid up so as to maintain an approximately uniform height throughout the structure and not have one (1) part built up materially in advance of another. Stone shall be laid so as to fit neatly and form a substantial wall. Care shall be exercised to see that each stone has a firm bearing on at least three (3) separate points on the underlying course. All interstices in the heart of the wall shall be filled with spalls. Open joints both front and rear shall be chinked with spalls fitted to take firm bearing upon the top and bottom surfaces. Face joints shall not exceed one inch (1″) in width. When required by the Special Provisions, the open joints on the rear of walls shall be "slushed" thoroughly with mortar to prevent seepage of water in joints.

B. When required by the Special Provisions, designed upper portions of the wall shall be laid in mortar to produce masonry of a character such as that described under 04 43 00.03, (Class 'B' Rubble Masonry). The Special Provisions may also require the top of the wall to be finished with a coping. Copings may be of stone or concrete, as required by the Special Provisions. Concrete copings may be pre-cast units set in place on full mortar beds or they may be cast-in-place using three thousand (3000) psi concrete and constructed according to the applicable requirements of 03 30 00, (Portland Cement Concrete Structures). Tops of concrete coping shall be finished and pitched to provide adequate drainage. Stone coping, unless otherwise noted, shall have a scabbled finish. Individual pieces shall not be less than eight inches (8″) thick, at least as wide as the top of the wall and not less than twenty-four inches (24) long. They shall be set in full mortar beds.

3.5 BACKFILLING

Dry rubble masonry walls may be backfilled as soon as constructed, except where back faces are slushed with mortar, backfilling shall not proceed until this mortar has set at least twenty-four (24) hours.

PART 4 MEASUREMENT AND PAYMENT

A. This item, according to the requirements of the Plans or Special Provisions or the method indicated in the Proposal, will either not be measured or will be measured on the basis of the volume of the Work satisfactorily completed and accepted, including copings,

determined from measurements made by weighing the material and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor and the Engineer, before such method of measurement of pay quantities will be approved by the Engineer.

B. This item will be paid for, as indicated in the Proposal, either on the basis of the Contract lump sum price of the Contract Unit Price per cubic yard for 04 43 00.03, (Class 'B' Cement Rubble Masonry) measured as described above, which price and payment shall be full compensation for all labor, materials and incidentals necessary to satisfactorily complete the Work as specified, including any mortared Work or special copings required.

DIVISION 05
METALS
05 05 00 COMMON WORK RESULTS FOR METALS

05 05 13.01 FUSION BONDED POWDER COATINGS FOR METAL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and applying electrostatically applied fusion bonded powder coatings on metal surfaces as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Epoxy Powder Coating. Epoxy Powder Coating shall conform to the following except creep test will not be required.

1. The epoxy protective coating shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. For reinforcement steel, the color shall be bright, in order to contrast with the normal color of reinforcement and rust (e.g. orange, red, green, yellow etc. and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the pre-qualified materials list from the Engineer.
2. Epoxy coatings shall conform to M 284.

B. Polyester Powder Coating. The polyester powder shall be a super durable TGIC (Triglycidyl Isocyanurate) polyester conforming to paragraph 2.1 B 5 below. The polyester powder shall be selected from the pre-qualified materials list.

1. Material used for the touch-up system shall be a two (2) component aliphatic polyurethane conforming to the following and color matched for patching the polyester coating used. The coating thickness of the touch-up material shall be the same as the thickness of the polyester and can be applied in multiple coats.

a. Aliphatic Urethane. Aliphatic urethane finish coat shall have minimum solids of seventy percent (70%) by weight and forty-seven percent (47%) by volume. Drying time to touch and harden shall be the minimum recommended by the paint manufacturer.

2. Cleaning and Coating. Cleaning and coating shall be performed in an environmentally controlled plant that is fully enclosed and approved by the City.

a. All items to be coated shall be free of any oil or grease, and shall be abrasive blasted to near white in conformance with SSPC SP-10. Cleaned surfaces shall be protected from high humidity, rainfall and surface moisture, and shall not be allowed to flash rust. The blast profile shall be

two (2) to three (3) mil as determined in conformance with D 4417, Method C.

b. The thickness of the cured coating shall be seven (7) mil, plus or minus two (± 2) mil when measured in conformance with D 1186.

c. The cured coating shall have a pencil hardness of 2H when tested in conformance with D 3363.

d. The color of the coating shall match the federal standards color number specified in the Contract Documents.

e. Using a 67-1/2 volt wet sponge detector, the polyester coating shall be checked for holidays, pinholes, and discontinuities. There shall be no more than one (1) deficiency per five (5) ft^2.

3. Acceptance. The acceptance of a polyester powder will be based on the quality control test results required on the manufacturer's certification. The coating applicator shall be responsible for reviewing certifications to ensure conformance to the following paragraph 2.1 B 4. The coating applicator shall also maintain a file of all reviewed certifications.

4. Certification. The polyester powder manufacturer shall furnish production batch certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification shall also show the conformance to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Infrared Spectrogram	D 2621	Match prequalification sample
Taber Abrasion Resistance, mg loss, max	D 4060	100
Specific Gravity	D 5965(Method A)	Prequalification sample ± 0.02
Color	E 1331 or E 1338	Match Federal Standard 595 color no. specified in Contract Documents

5. Polyester Prequalification Requirements. The following physical tests will only be required to prequalify the polyester, and will not be required for certification:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Abrasion Resistance	Taber Abraser CS-10, 1000 gm load, 1000 cycles, D 1044	100 mg max weight loss
Adhesion	D 3359, Method A (Bonderite 1000 panel	Rating 5A
Gloss	D 525, 60° initial	30 - 45 per Federal Standard 595
Hardness	D 3363	Min 2H - No gouge
Impact	D 2794	Pass 80 inch·lb
Salt Spray Resistance	B 117, D 1654 12000 hr (Bonderite 1000 panel)	Table 2, Rating 7
Thickness	G 12	7 ± 2 mil
Color	E 1331 or E 1338	As specified in the Contract Documents from Federal Standard 595 20040
Infrared Spectrogram	Equipment manufacture's procedures	Manufacturer's IR
Weather Resistance	D 4587, test condition D Test shall be conducted with a UVA lamp (340 nm peak) for 1000 hr	50 % min gloss retention
Specific Gravity	D 5965	Manufacturer's result

C. Polyester powder coating shall be used unless otherwise specified.

PART 3 EXECUTION

3.1 GENERAL

A. The coating shall be applied in an environmentally controlled plant that is fully enclosed. The coating system shall have the capabilities of preheating and post baking.

B. All metal surfaces shall be free of oil or any mill coating.

C. All metal surfaces shall be grit blasted to white metal as specified in SSPC-SP 5 using a mixture of steel shot and grit. Cleaned surfaces shall be protected from conditions of high humidity, rainfall or surface moisture. The metal surfaces shall not flash rust before coating. Blast profile shall be a uniform, angular anchor profile with a height of two (2) to five (5) mil. Anchor pattern shall be checked with an approved surface profile gauge.

D. The coating material shall be applied and cured as specified by the coating manufacturer. The metal surfaces and oven temperatures shall not exceed five hundred degrees (500°) F during any part of the curing process.

E. The cured coating shall be of uniform color, gloss, and thickness, and shall be free of blisters, fish eyes, sags, runs, and any other irregularities.

F. The finished coating thickness shall be ten (10) mil, plus or minus two (± 2), mil when tested as specified in SSPC PA-2 except the balls and sockets on steel sheet piling may have a lesser thickness of coating.

G. New bolts, nuts, and washers shall be similarly coated with a thickness of four to seven (4 to 7) mil. The nuts shall have oversize threads and shall fit the bolts after both are coated. The bolt heads shall be restrained from turning during torquing operations.

H. The coater shall be responsible for all quality control checking including visual inspection and thickness measurements and shall keep the results of each inspection in a form suitable to the Engineer.

I. The Engineer shall have access to each part of the process and shall have the right and opportunity to witness or perform any of the quality control tests on a random sampling basis.

3.2 TOUCH UP

A. A compatible touch up system shall be provided for repair of defects, all areas damaged during erection, and all visible open areas. Touch up shall be applied by the Contractor as follows:

1. Surface Preparation. The coating shall be applied directly to the metal surface, which shall be clean, dry, and free of rust and scale. Blast clean to National Association of Corrosion Engineers (NACE) near white where possible. Grease, oil, etc., shall be removed with suitable solvents. The cleaned surface shall be coated before oxidation occurs.
2. Mixing. Mix ratio of Part A to Part B shall be as recommended by the manufacturer. The two (2) parts shall be thoroughly mixed until a uniform color is achieved. If thinning is required, each part shall be thinned separately with thinner recommended by the manufacturer. Material not used within the pot life recommended by the manufacturer shall be discarded.

3.3 MATERIAL PRECAUTIONS

The manufacturer's Material Safety Data shall be used in handling and use of this material.

PART 4 MEASUREMENT AND PAYMENT

Fusion bonded powder coatings for metal will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

05 12 00 STRUCTURAL STEEL FRAMING

05 12 00 STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing, fabricating, transporting and erecting steel beams, plate girders, trusses, grillages, columns and bents, shoes, pedestals, castings, miscellaneous steel and all incidental structural steel as specified in the Contract Documents or as directed by the Engineer.

B. Substitutes for Rolled Members: The Contractor/Fabricator has the option of substituting a fabricated shape for the rolled shape specified in the Contract Documents provided the substitution is at no additional cost to the City and the fabricated shape conforms to the following requirements:

1. The substitute fabricated shape shall provide a moment of inertia equal to or greater than the rolled shape for the full length of the member.
2. The substitute fabricated shape shall be of equal depth or greater than the rolled shape and not decrease the under clearance shown in the Contract Documents.
3. The minimum web or leg thickness for fabricated shapes is one-half inch (1/2″).
4. The minimum flange thickness for fabricated shapes is one inch (1″). The minimum flange width for fabricated shapes is twelve inches (12″). The width to thickness ratio for fabricated flanges shall not exceed twelve (12).
5. The fabricated shape shall be made of the same material specified for the rolled shape.
6. All normal criteria for creating a welded member are adhered to.

PART 2 PRODUCTS

2.1 MATERIALS

A. Grout

1. Nonshrink grout shall be used when specified. The grout shall have a minimum compressive strength of five thousand (5000) psi in seven (7) days when tested as specified in T 106, except that the cube molds shall remain intact with a top firmly attached throughout the curing period. The nonshrink grout shall have a minimum expansion of zero percent (0.0%) after seven (7) days when tested as specified in T 160.
2. Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of sixty five hundred (6500) psi in seventy two (72) hours when tested as specified in MSMT 501.
3. The natural or manufactured sand for epoxy grout shall conform to the following:

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

MATERIAL	**SIEVE SIZE**								
	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
FINE AGGREGATE/SAND MORTAR and EPOXIES	100	95–100	—	—	—	—	—	0–25	0–10

4. An epoxy or polyester anchoring system may be used when approved by the Engineer in conformance with the manufacturer's recommendations. Strength values shall be as specified in the Contract Documents.

B. Metals

1. Certification: The metal producer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual mill test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The chemical and physical properties of the finished metal products shall also be furnished by the processing manufacturer.
2. Structural steel: Structural steel shall conform to the requirements specified in the Contract Documents. All primary load-carrying members shall conform to the supplementary toughness requirements of M 270, Zone 2.
   Primary load carrying members are as follows or as designated in the Contract Documents: Finger joint steel from which saw tooth configurations have been cut, all stringers, cover plates, bearing stiffeners, splice plates, pins and pin links for straight rolled steel beam bridges; all flanges, webs, bearing stiffeners, splice plates, pins and pin links for straight steel girder bridges. Additionally, on curved rolled steel beam and steel girder bridges; all diaphragms, cross frames, lateral bracing, including connection plates to main stringers.
3. Steel for miscellaneous use: Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.
4. Welding materials: Welding materials shall conform to American Welding Society (AWS) D1.5.
5. Gray iron castings: Iron castings shall conform to A 48, Class 30B.
6. Steel stud shear developers: Shear developers shall conform to American Welding Society (AWS) D1.5.
7. Bolts, nuts and washers for general use: Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.
8. High strength bolts, nuts and washers: High strength bolts, nuts and washers shall conform to A 325.
9. Anchor Bolts for Traffic Signals, Highway Lighting, and Signs: Anchor bolts for traffic signals, highway lighting, and signs shall conform to F 1554, Grade 55 S1. Anchor bolts shall be galvanized for the full length of the threads and 3 inches below the threads in conformance with A 153. Nuts shall be hex nuts conforming to A 194, Grade 2H or A 563 Grade DH. Flat washers shall be heavy washers conforming to F 436. All hardware shall be galvanized in conformance with A 153.Cast washers: Cast washers, ogee washers, and special cast washers shall conform to A 47. Cast washers shall be hot dip galvanized. The coating shall conform to the thickness, adherence, and quality requirements of A 153.
10. Hardware: Spikes, wood screws, staples, brads, lag screws, carriage bolts, and other parts under the general heading of "Hardware" shall be composed of carbon steel and shall conform to Federal Specification FF-N-105.
11. Steel forms: Steel bridge deck forms and deck form supports which remain in place shall be fabricated from steel conforming to A 653, Designation SS, Grades 33 through 80, Coating Designation G 165. The minimum thickness of uncoated steel shall be point zero three five nine inches (0.0359″).

C. Bolts shall conform to A 325.

D. Nuts shall conform to A 194.

E. Washers shall conform to F 436.

F. Direct Tension Indicating Washers (DTI) shall conform to F 959.

PART 3 EXECUTION

3.1 GENERAL

Unless otherwise specified, all welding and dimensional tolerances shall conform to AWS D1.5.

3.2 WORKING DRAWINGS

A. Working Drawings shall be provided by the Contractor as specified herein.

B. The Plans will be supplemented by Working Drawings as necessary to adequately control the Work. All authorized alterations affecting the requirements and information given on the Working Drawings shall be in writing to the Engineer. When reference is made to the Working Drawings, the interpretation shall be the Working Drawings as affected by all authorized alterations then in effect.

C. Working Drawings will show details of all structures, lines, grades, typical cross section of roadway, general cross sections, location and designation of all units and elements.

D. The Contractor shall provide, at no additional cost to the City, all required Working Drawings and shall have them adequately checked, after which they shall be submitted to the Engineer for review.

E. The Engineer may reject Working Drawings and return them for revisions, in which case the Contractor shall submit revised Working Drawings as required. No items involving the drawings shall be incorporated into the Work until the drawings have been accepted for use by the Engineer; however, acceptance shall not relieve the Contractor of any responsibility in connection with them.

F. All Working Drawings shall be furnished in duplicate for preliminary examination for projects prepared by the City and in triplicate for projects prepared by consultant engineering firms for the City. After Working Drawings have been accepted for use by the Engineer, the Contractor shall furnish additional copies as requested.

G. All Working Drawings shall be on sheets measuring twenty-two inches by thirty-six inches (22″ X 36″) and shall have a standard title block at the lower right corner approximately four inches by eight inches (4″ X 8″) (two inches (2″) for the revision column on the left side and the remaining 6 inches (6″) for the title) indicating the following information in the order named:

1. Name of Contractor: (and subcontractor, if applicable)
2. Address of Contractor: (and Subcontractor, if applicable)
3. Sheet Title: (Reinforcement Details, etc.)
4. Name of Structure:
5. Crossing:
6. For: (City of Baltimore)

7. By: (Indicate name of Contractor's official or engineer, or other parties authorized to sign official documents.)
8. List Contract number, complete federal aid number, if any, and the date the drawing was completed. The left portion of the title block shall be headed "Revisions" and the space used as needed.

H. The Working Drawings shall be submitted for review to the Engineer. A copy of the transmittal letter shall be forwarded to the Engineer. The number of Working Drawings to be furnished shall be as specified above.

I. The Contractor is responsible for the erection of straight and curved girders and if lateral bracing is required for shipping or erection, the details shall be specified on the Working Drawings.

3.3 WORK SCHEDULING

The Contractor shall give a minimum of two (2) weeks notice to the Engineer when and where shop Work shall begin to allow for inspection. No materials shall be fabricated until directed by the Engineer.

3.4 FACILITIES FOR SHOP INSPECTION

The Contractor shall furnish all facilities for the inspection of material and workmanship in the shop. The Inspector shall be allowed free access to the required areas of the premises and shall be provided with an approved office area.

3.5 MATERIAL IDENTIFICATION

Main member material shall be identified by the Contractor by heat number.

3.6 MILL ORDERS

The Contractor shall furnish the Engineer with copies of mill orders and test reports.

3.7 TESTING

The Contractor shall furnish, without charge, sample specimens as directed by the Engineer.

3.8 DEFECTIVE MATERIAL AND WORKMANSHIP

The acceptance of any material and workmanship by the Inspector will not deter subsequent rejection. Rejected material and workmanship shall be replaced or repaired as directed by the Engineer.

3.9 MARKING AND SHIPPING

A. Each member shall be painted or marked with an erection mark for identification. An erection diagram shall be furnished with erection marks clearly delineating the orientation of diaphragms.

B. Erection marks for the field identification of members and weight marks for members over six thousand (6000) lb in weight shall be painted upon surface areas previously painted with the shop coat. Material shall not be loaded for shipment until the shop coat is thoroughly dry and in any case not less than twenty-four (24) hours after the paint has been applied.

C. Where unpainted steel is specified for a finished structure, the Contractor shall not place the Contractor's or any other company's name on any of the structural steel. Mark numbers and inspection stamps shall appear only on the top surface of the top flange of all girders, beams, and diaphragms unless otherwise directed.

D. Painting is prohibited after loading of materials for transport.

E. The Contractor shall furnish the Engineer copies of material orders, shipping statements, and erection diagrams. The weight of the individual members shall be shown on the shipping statements.

F. The loading, transportation, unloading, and storing of structural material shall be conducted so that the metal shall be kept clean and shall not be excessively stressed, deformed, or otherwise damaged.

G. When handling long steel members, handling devices shall be placed at approximately the quarter points. When storing and shipping members, blocking shall be placed at intervals that prevent sag and distortion. All beams and girders shall be stored, shipped, and handled in an upright position. Members other than beams and girders shall be handled, hauled, and stored with the stronger axis vertical to resist gravity.

H. All girders having stiffeners the full height of the web on both sides of the web shall be adequately blocked before shipment. This blocking shall be located at the quarter points and midpoint of the girder and at additional locations to ensure that the maximum interval between blocking does not exceed twenty-five feet (25').

I. Members too long to fit inside a truck or trailer shall not cantilever beyond the bed more than one-quarter (1/4) of its length. Members too long to comply with this requirement shall be supported on dollies, additional vehicles, or other vehicles that fully support the long pieces as approved by the Engineer.

3.10 STORAGE OF MATERIAL

Fabricated material shall be stored off the ground and protected as far as practicable from surface deterioration by exposure to conditions producing rust. These materials shall be kept free of dirt accumulation, oil, or other deleterious matter.

3.11 CHANGES AND SUBSTITUTIONS

No changes or substitutions shall be made in any approved drawing unless approved in writing by the Engineer.

3.12 FABRICATION

A. Fabrication and construction shall be bolted or welded as specified in the Contract Documents or as directed by the Engineer.

B. When curved girder bridges are to be curved by the heat shrinkage method, the proposed method shall be submitted to the Engineer for approval.

3.13 HOLES

A. Punched Holes: The diameter of the die shall not exceed the diameter of the punch by more than one-sixteenth inch (1/16″). Holes requiring enlargement shall be reamed. Holes shall be clean cut with no torn or ragged edges. Holes punched full size or sub-punched shall be punched so that after the steel is assembled and before any reaming is done, a cylindrical pin one-eighth inch (1/8″) smaller in diameter than the nominal size of the punched hole shall be entered perpendicular to the face of the member, without drifting, in at least seventy-five percent (75%) of the contiguous holes in the same plane. If this requirement is not met, the nonconforming punched pieces will be rejected. Holes not passing a pin three-sixteenths inch (3/16″) smaller in diameter than the nominal size of the punched hole will be rejected. Drifting done during assembling shall be only to bring the parts into position and not sufficient to enlarge the holes or distort the material. If the required accuracy cannot be obtained otherwise, holes for connections shall be sub-punched and reamed with the members assembled instead of being punched full size.

B. Reamed or Drilled Holes: Holes shall be cylindrical, perpendicular to the member, and not more than one-sixteenth inch (1/16″) larger than the nominal diameter of the bolts. Where practical, reamers shall be directed by mechanical means. Burrs on the surface shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the Engineer, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match marked before disassembling. When holes are reamed or drilled, eighty-five percent (85%) of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than one thirty-second inch (1/32″) between adjacent thicknesses of metal.

C. Sub-punching and Reaming: Holes in all field connections and field splices of main truss or arch members, continuous beams, plate girders, and rigid frames shall be sub-punched and reamed while assembled in the shop unless otherwise specified. The assembly, including camber, alignment, accuracy of holes, and milled joints shall be acceptable to the Engineer before reaming is started. All holes for floor beam and stringer field end connections shall be sub-punched and reamed utilizing a template or reamed while assembled. If additional sub-punching and reaming is required, it will be specified in the Contract Documents. The accuracy of sub-punched holes shall be the same as required for punched holes.

3.14 SHOP ASSEMBLY

A. Surfaces of metal that will be in contact after assembling shall be cleaned. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or tightening of fasteners is started. The member shall be free from twists, bends and other deformations. Material that has been punched full size shall be reamed, if necessary, prior to tightening of fasteners. Refer to the aforementioned paragraph 3.13, C.

B. Parts not completely fastened in the shop shall be secured by bolts as practical to prevent damage in shipment and handling. Members assembled in the shop for reaming of field connections shall remain assembled until the Engineer's shop inspection.

3.15 CAMBER DIAGRAM

A. A camber diagram shall be furnished to the Engineer showing the camber at each panel point for each truss, taken from actual measurements during truss assembly. A camber diagram shall be furnished to the Engineer showing the camber at all splice points, points of dead load inflection, and any other points designated by the Engineer for all beams and girders.

B. Stringers shall be cambered to the dimensions specified in the Contract Documents. The camber specified shall mean the camber as measured after all shop welding has been completed. The maximum tolerance for camber shall be zero (0) under to three-quarters inch (3/4″) over.

C. Full provisions shall be made for dead load deflections, fabricating tolerances, and irregularities at all points along all stringers so that the superstructure concrete may be placed to match the profile grade line.

3.16 MATCH MARKING

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matched marked, and a diagram showing these marks shall be furnished to the Engineer.

3.17 USE OF HIGH-STRENGTH BOLTS AND LOCK-PIN AND COLLAR FASTENERS

High-strength bolts and lock-pin and collar fasteners shall be used unless otherwise specified in the Contract Documents. Unfinished bolts or machine bolts may be used for the temporary erection of structural steel and shall be replaced with high-strength bolts, lock-pin and collar fasteners or welding for final erection. Turned bolts shall only be used when specified. The heads, nuts, and washers shall be drawn tightly against the work. Where bolts or lock-pin and collar fasteners are used in beveled surfaces, beveled washers shall be provided to give full bearing to the head, nut, or collar except as otherwise specified in paragraph 3.18 of this section. Where high-strength bolt assemblies are used for joint connections, the Contractor shall also perform the additional testing specified in Maryland Standard Methods of Tests (MSMT) 211.

3.18 HIGH-STRENGTH BOLT JOINT REQUIREMENTS

A. Only one grade of bolts, nuts, and washers shall be used in a structure. Bolts may be supplied from various manufacturers provided that each bolt of a given length and diameter shall be made by the same manufacturer. Nuts and washers may be supplied from different manufacturers provided that the same manufacturers make all the respective nuts and washers to be used throughout the structure on all bolts having the same diameter. All bolts, nuts, and washers used with A 709, Grade 50W steel shall conform to A 325, Type 3.

B. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed one to twenty (1:20) with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than one to twenty (1:20) with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism. When assembled, bolted parts shall fit solidly together and shall not be separated by gaskets or any other interposed compressible material. The holes shall be

truly cylindrical and at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. When assembled, all joint surfaces including those adjacent to the bolt heads, nuts, or washers, shall be free of scale (except tight mill scale), dirt, burrs, and other deleterious material and defects that would prevent solid seating of the parts. Contact surfaces within joints shall be free of oil, lacquer, or rust inhibitor.

C. When all bolts in the joint are tight, every bolt shall conform to the minimum installation tension for its size. When field conditions prevent tightening at the nut, bolts may be tightened at the head, provided that the nut is prevented from turning. All bolts shall have a washer under the element (nut or bolt head) turned in tightening. Threaded bolt connections shall be tightened by the turn-of-nut method unless the Contractor opts to use DTI's. If impact wrenches are used, they shall be of adequate capacity and have a sufficient supply of air to perform the required tightening of each bolted connection.

D. To provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be additionally tightened with tensioning progressing systematically from the most rigid part of connection to the free edges. During this operation there shall be no rotation of the part not turned by the wrench.

E. After all bolts in the joint have a snug fit; the joint shall be additionally tightened by the applicable amount of nut rotation specified in the Nut Rotation from Snug Tight Condition table below. All bolt assemblies in the completed structure shall have full thread engagement, which is accomplished when the end of the bolt is flush with or extends beyond the outer face of the nut.

NUT ROTATION FROM SNUG TIGHT CONDITION			
DISPOSITION OF OUTER FACES OF BOLTED PARTS			
Bolt length (as measured from underside of head to extreme end of bolt)	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (beveled washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

Note 1 This table is for coarse thread, heavy hexagon structural bolts of all sizes and lengths and heavy hexagon semifinished nuts.

Note 2 Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation: Plus or minus thirty degrees (±30°) for bolts installed by one-half (1/2) turn or less, and plus or minus forty-five degrees (±45°) for bolts installed by two-thirds (2/3) turn or more.

F. Inspection. The Engineer will be present during the installation and tightening of bolts to determine that the tightening procedure is properly followed and all bolts are properly tightened. The Contractor shall provide a sufficient number of safe working platforms at splices where high-strength bolts will be checked for torque requirements. Platforms shall be maintained at splices until all checking is complete and the splice is acceptable to the Engineer.

G. Turn of Nut Method. The Contractor shall provide a calibrated torque wrench to be used as the inspection wrench and a calibrated bolt tension calibrator. Both have to be approved by the Engineer.

H. The Contractor shall conduct the following inspections unless otherwise specified in the Contract Documents. Bolts, nuts, and washers that were previously torqued to installation tension shall not be reused in the structure.

1. Three (3) bolts of the same size, length, and condition, as those under inspection shall be placed individually in the bolt tension calibration device. There shall be a washer under the part turned in tightening each bolt.
2. Each of the three (3) bolts shall be tightened in the calibration device by any convenient means to the tension specified for its size. The inspecting wrench shall then be applied to the tightened bolt, and the torque necessary to turn the nut or head 5 degrees approximately one inch (1″) at a twelve inch (12″) radius in the tightening direction shall be determined. The average torque measured in the tests of three (3) bolts shall be taken as the job inspecting torque to be used in the manner specified in the following paragraph.
3. Bolts represented in the sample above which have been tightened in the structure shall be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to ten percent (10%) of the bolts but not less than two (2) bolts selected at random in each connection. If no nut or bolt head is turned by this application of the job inspecting torque, the connection will be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection; and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and re-inspected. Alternatively, the fabricator or erector may opt to retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

3.19 LOCK-PIN AND COLLAR FASTENER REQUIREMENTS

A. Lock-pin and collar fasteners shall conform to “High Strength Bolt Joint Requirements” for one manufacturer, weathering characteristics, sloped surfaces, and applicable inspection.

B. A representative sample of not less than three (3) sets of lock-pin and collar fasteners of each diameter, length, and grade shall be checked at the job site in a device capable of indicating bolt tension. The test assembly shall include flat hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The calibration test shall demonstrate that each assembly develops a tension not less than five percent (5%) greater than the tension required for the comparable A 325 or A 490 bolt. Manufacturer’s installation procedure shall be followed for installation of bolts in the calibration device and in all connections. Periodic retesting shall be performed when required by the Engineer.

C. Fasteners shall be installed in all holes of the connection and initially tightened sufficiently to bring all plies of the joint into firm contact but without yielding or fracturing the control or indicator element of the fasteners. All fasteners shall then be additionally tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the fasteners may require more than a single cycle of systematic partial tightening prior to final twist off of the control or indicator element of individual fasteners.

3.20 WELDING

A. Welding of structures shall conform to the Contract Documents and American Welding Society (AWS) Bridge Welding Code D1.5 unless otherwise specified.

B. The provisions contained herein shall apply to both shop and field welding.

1. All welders, welding machine operators, and tackers employed to work on structures for the City shall be approved based on qualification testing conforming to American Association of State Highway and Transportation Officials (AASHTO)/American Welding Society (AWS) Bridge Welding Code D1.5.
2. Unless otherwise specified by the Engineer in writing, only submerged arc welding will be permitted on members carrying primary stress.
3. Members carrying primary stress are as follows or as designated in the Contract Documents: Finger joint steel from which saw tooth configurations have been cut, all stringers, cover plates, bearing stiffeners, splice plates, pins and pin links for straight rolled steel beam bridges; all flanges, webs, bearing stiffeners, splice plates, pins and pin links for straight steel girder bridges. Additionally, on curved rolled steel beam and steel girder bridges; all diaphragms, cross frames, lateral bracing, including connection plates to main stringers.

C. After fabrication, no welding will be permitted on tension flanges for attachments such as metal forms and tie screws, except for steel stud shear developers specified in the Contract Documents.

D. Welding transversely across the tension flanges of beams or girders will not be permitted and will be cause for rejection unless otherwise specified in the Contract Documents.

3.21 INSPECTION OF FABRICATED METAL STRUCTURES

A. Fabricated metal structures shall conform to American Association of State Highway and Transportation Officials (AASHTO)/American Welding Society (AWS) Bridge Welding Code D1.5. Quality control inspection shall be the responsibility of the Contractor.

B. The Contractor shall have on file a current approved quality control plan prior to receiving source approval. This plan shall specify the frequency, method of inspection and provide for documentation. The inspection frequency shall be at least the minimum specified in AASHTO/AWS Bridge Welding Code D1.5. The City requires thirty (30) days to review quality control plans not previously on file.

C. The Contractor shall also keep complete and current records which shall be available to the City's representatives at all times.

D. When Work is completed, the documentation for all quality control tests and inspections shall become the property of the City.

3.22 PLANING

The top and bottom surfaces of steel slabs, base plates, and cap plates of columns and pedestals shall be planed or the plates or slabs shall be heat straightened. Parts of members in contact with them shall be faced. In planing the flat surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

3.23 ABUTTING JOINTS

Abutting joints in compression members and in tension members where specified in the Contract Documents shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed one-eighth inch (1/8″).

3.24 END CONNECTION ANGLES

Floor beams, stringers, and girders having end connection angles shall be built to exact length back-to-back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than specified in the Contract Documents.

3.25 MAIN MEMBERS

Principal portions of main members carrying primary stress (i.e., webs, flanges, girders and trusses) shall be fabricated so that the direction of stress and rolling are the same.

3.26 WEB PLATES

At web splices, the clearance between the ends of the web plates shall not exceed three-eighths inch (3/8″). The clearance at the top and bottom ends of the web splice plates shall not exceed one-quarter inch (1/4″).

3.27 BENT PLATES

A. Unwelded, cold bent, load carrying, rolled steel plates shall be taken from the stock plates so that the bend line will be at right angles to the direction of rolling, except that cold bent ribs for orthotropic deck bridges may be bent in the direction of rolling if permitted by the Engineer and shall conform to the following:

1. Bending shall be so that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal shall conform to the following:

	THICKNESS (t) IN INCHES				
Structural Steel	Up to 1/2	Over 1/2 to 1	Over 1 to 1-1/2	Over 1-1/2 to 2-1/2	Over 2-1/2 to 4
A 709, Grades 36, 50 & 50W	2 (t)	2-1/2 (t)	3 (t)	3-1/2 (t)	4 (t)

2. For brake press forming, the lower die span should be at least sixteen (16) times the plate thickness. Multiple hits are advisable.

3. If a shorter radius is essential, the plates shall be bent at a temperature not greater than twelve hundred degrees (1200°) F. Hot bent plates shall be taken from stock so that the bend line will be at right angles to the direction of rolling.
4. Before bending, the corners of the plate shall be rounded to a radius of one-sixteenth inch (1/16″) throughout the portion of the plate where the bending is to occur.

3.28 ERECTION PLAN

A. The Contractor shall submit for approval, an erection diagram plan outlining erection procedure of the main members. The plan shall comply with the provisions of aforementioned paragraph 3.2. The plan shall be submitted for approval to the City, a minimum of thirty (30) days prior to beginning erection. This plan shall include the numbers and types of equipment to be used including crane capacity, location of crane for lifting, falsework when required, and main member erection sequence and weight.

B. All wheels and outriggers of a crane or wheels of a structural steel delivery truck shall be at a minimum distance from the rear face of an abutment equal to the vertical distance from the top of a spread footing or to the original groundline if the footing is on piles. No other heavy construction equipment shall be operated within this minimum distance from the rear face of abutments.

C. The Contractor shall erect bridges with continuous main members in a manner providing the proper reactions, and avoiding overstressing main members.

D. The Contractor when preparing erection plans and procedures shall take into account the restrictions imposed by the Water Resources Administration relative to pollution or disturbance of existing waterways.

3.29 FALSEWORK

A. Working Drawings for Falsework Systems:

1. Falsework systems plans (design and construction) shall be the responsibility of the Contractor, including submitting and obtaining written acceptance of the design and plans by the Engineer before erection.
2. The Contractor shall utilize a professional engineer (P.E.) registered in the State of Maryland who has a minimum of five (5) years experience in falsework design for bridge construction and repair. The falsework design calculations and plans shall be signed by the P.E. and bear the seal of the P.E. The submittal of the design and falsework plans shall include the P.E.'s resume showing evidence of the required experience.
3. The P.E.'s plans and design calculations shall evaluate and qualify all products and components including manufactured products and proprietary items for their intended service. Acceptance by the Engineer of falsework systems shall not in any way relieve the Contractor of the responsibility for the safety and adequacy of the design and construction for the falsework systems and operations, including all components.
4. Every structure in the construction Contract will require a separate falsework design analysis, separate plans, and design submittal as set forth above. This applies even though structures may appear to be identical.

5. Each falsework system shall be designed to support all vertical and horizontal loading with enough redundancy to prevent progressive failure. Vertical loading, differential settlement forces, live load where applicable, and all horizontal lateral and longitudinal forces shall be taken into account. Unbalanced temporary loading caused by placement sequence shall also be provided for in the design. Adequate diagonal bracing in all planes shall be employed.
6. All falsework systems designs and plans shall provide for adequate foundations with bearings below the frost line or on rock or on piling and for possible settlement. If additional subsurface data is necessary, it shall be obtained and analyzed for proper design of the plans and performance of construction.
7. Falsework designs and plans shall include protection against impact from uncontrolled highway vehicles, accidental collision of a crane boom or other construction equipment and vehicles, traffic vibration, floodwaters, high winds, and any other envisioned contingent situations.

B. The falsework shall be built and maintained in conformance with the approved falsework plans. Any changes subsequent to initial approval which are proposed by the Contractor through the Contractor's professional engineer will be as approved by the Engineer.

C. Before permitting any loads to be placed on falsework, the Engineer shall receive written certification by the Contractor's professional engineer that the falsework system has been assembled in conformance with the approved falsework drawings. This certification shall be accompanied by a certificate of compliance stating that all manufactured materials and assemblies fully comply with the falsework design and plans. All tests required shall be made by the Contractor at no additional cost to the City.

D. In addition to protective measures shown on the falsework plans, the Engineer may direct the Contractor to provide further protection of falsework against accidental collision by highway or construction traffic and equipment, traffic vibration, flood waters or high winds, etc., that are necessary for public safety and protection of the work.

3.30 DAMAGED OR DEFECTIVE MATERIAL

The correction of damaged or defective material shall not begin until a written procedure prepared by the Contractor is approved by the Engineer. Correction of damaged or defective material shall be by methods that do not produce fracture or injury. All damaged or defective material will be inspected by the Engineer before and after correction. Corrections shall be conducted in the presence of the Engineer.

3.31 ASSEMBLING STEEL

Material shall be carefully handled and no parts shall be bent, broken, or otherwise damaged. Bearing surfaces and those to be in permanent contact shall be cleaned before the members are assembled. Before beginning the field bolting and welding, the structure shall be adjusted to correct grade and alignment and the elevations of panel points (ends of floor beams) properly regulated. Splices and field connections shall have half the holes filled using bolts and cylindrical erection pins (forty percent (40%) bolts and ten percent (10%) pins) before torquing high-strength bolts. Splices and connections in members carrying traffic during erection shall have three-fourths (3/4) of the holes filled before torquing. Cylindrical erection pins shall be one thirty-second inch (1/32″) inch larger than the diameter of the fasteners.

3.32 ANCHOR BOLTS

A. No anchor bolts shall be cast in the concrete. The Contractor shall create a template to locate the anchor bolt holes. This template shall be used to shift the reinforcement prior to placing the concrete to eliminate conflicts between the reinforcement and the anchor bolt holes.

B. Anchor bolts shall be set in round holes drilled or cast in the concrete. Bolts shall be accurately positioned by using templates set to correct location and alignment to ensure proper span lengths, and tops of bolts shall be carefully set to proper elevation. Unless otherwise noted, bolts shall be installed plumb or normal to the finished bearing surface of the masonry.

C. Bolts set in holes drilled or cast into the concrete shall have the portion below the bridge seat swedged. The drilled or cast holes shall have a diameter at least one inch (1″) larger than the bolt diameter.

D. Anchor bolts, nuts, and washers shall not be painted.

E. After anchor bolts are finally and correctly positioned, the holes shall be completely filled with grout. Grouting of anchor bolts is not permitted until all structural steel is set in its final position. After the masonry plates or shoes are set, the space between the bolts and the round holes through fixed plates or shoes shall be filled with the same material. Slotted holes in expansion devices shall remain unfilled unless otherwise specified in the Contract Documents.

F. The Contractor shall maintain a minimum air temperature of forty degrees (40°) F around the mortar surface for a period of three (3) days unless otherwise recommended by the manufacturer.

G. When mortar filling is used for bolts inserted in holes drilled or cast in the concrete, the holes shall first be checked for depth by inserting and withdrawing the bolts. They shall then be partially filled with mortar into which the bolts shall be forced by uniform pressure or light blows from a hammer (flogging and running is prohibited) so that excess mortar is pushed out at the top of the hole. The excess mortar shall be removed.

H. Bolts shall be set to project approximately one-half inch (1/2″) above the nut and shall be threaded to approximately one-half inch (1/2″) below the nut in their final position.

I. Rockers or expansion plates with slotted holes shall be set with the proper tilt or offset as determined by the temperature prevailing at the time and so that they will be in their midway position at sixty-eight degrees (68°) F or as specified in the Contract Documents.

3.33 MAINTENANCE OF CONCRETE

The Contractor shall be responsible for keeping all exposed concrete surfaces free from stains and discoloration. The Contractor shall prevent staining of the finished concrete surfaces where unpainted structural steel is specified. Any stains shall be removed and the concrete restored to its original color.

3.34 SAFETY HAZARDS

A. The Contractor shall be responsible for gas detection in and ventilation of confined spaces.

B. When procedures require workers to enter confined spaces such as steel or concrete box section type superstructures, particularly when the interior is closed off at both ends, the Contractor shall be cognizant of the potential health hazards.

C. The Contractor shall adhere to all applicable Maryland Occupational, Safety and Health (MOSH) regulations. The Contractor shall have approved detecting devices available and shall conduct tests for oxygen content and presence of gases, such as combustible gas, carbon dioxide, methane, carbon monoxide, and hydrogen sulfide whenever any fabrication, erection or inspection operations are to be performed within the confined spaces. The Contractor shall apply mechanical ventilation continuously to the confined space during occupancy to maintain the proper oxygen content and shall conduct air tests periodically during the occupancy.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all high-strength bolts and lock-pin and collar fastener assembly testing, material, labor, equipment, tools, and incidentals necessary to complete the work.

B. Fabricated Structural Steel will not be measured but will be paid for at the Contract lump sum price.

C. Fabricated Structural Steel will be measured and paid for at the Contract Unit Price per pound computed on the theoretical weight.

1. Where measurement and payment of Fabricated Structural Steel is based on weight, the weight will be computed on the basis of the net finished dimensions of the parts as shown on the approved Working Drawings, deducting for copes, cuts, clips, and all open holes.
2. Computations will be made on the basis of the following:

MATERIAL	POUNDS PER CUBIC FOOT
Aluminum, cast or wrought	173.0
Bronze, cast	536.0
Copper alloy	536.0
Copper, sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Lead, sheet	707.0
Steel, rolled, cast, copper bearing, silicone, nickel and stainless	490.0
Zinc	450.0

3. The weight of rolled shapes will be computed on the basis of their nominal weight per foot as specified in the Contract Documents or listed in the handbooks.

4. The weight of rolled shapes will be computed on the basis of their nominal weight for their width and thickness as specified in the Contract Documents, plus an estimated overrun computed as half the permissible variation in thickness and weight as tabulated per the Engineer.
5. The weight of all shop weld metal (not included in weighed unit) and field weld metal will be computed on the basis of the theoretical volume from dimensions of the welds.
6. The weight of temporary erection bolts, shop and field paint, boxes, crates and other containers used for shipping, and materials used for supporting members during transportation and erection is excluded from the calculation of weight for payment.
7. Structural members or materials which fail to conform to requirements of tests and all materials rejected as a result of these tests will not be measured or paid for under any method of payment.

D. When a pay item for Fabricated Structural Steel is not specified in the Contract Documents, the fabricated structural steel will not be measured but the cost will be incidental to other pertinent items

E. Rotational capacity testing for high-strength bolt assemblies will not be measured but the cost will be incidental to the Contract Price for the Fabricated Structural Steel item or other pertinent items specified in the Contract Documents.

05 41 00 STRUCTURAL METAL STUD FRAMING

05 41 00 STEEL STUD SHEAR DEVELOPERS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, fabricating and installing, complete in place, steel stud shear developers as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Steel stud. Shear developers shall conform to AASHTO AWS D1.5, Bridge Welding Code or AWS D1.1 Structural Welding Code.

PART 3 EXECUTION

3.1 GENERAL

All structural steel in a particular span of a bridge shall be erected and will have forming and decking complete in place in that particular span before shear developers are attached to the structural steel. Shear developers shall be installed as specified in AASHTO/AWS Bridge Welding Code D1.5. After welding is completed, an inspection of all studs will be made by the Engineer prior to the placing of concrete. All defects shall be corrected at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

B. Steel stud shear developers will not be measured but will be paid for at the Contract lump sum price.

C. Steel stud shear developers for which there is no specific pay item included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

D. Steel stud shear developers will be measured and paid for at the Contract Unit Price per each.

05 52 00 METAL RAILING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, fabricating, coating and erecting of all metal railings as specified in the Contract Documents.

1.2 SUMMARY

A. This Section includes the following type of railings:

1. Aluminum railings.
2. Steel railings.
3. Stainless Steel railings.

Use notes in italic to adjust requirements below to suit the Project.

1.3 PERFORMANCE REQUIREMENTS

Delete first two paragraphs and associated subparagraphs below if requirements are indicated on Drawings or if authorities having jurisdiction require structural engineer of record to take full responsibility for structural design. Delete first paragraph and subparagraphs if performance requirements are verified by testing rather than by engineering calculations.

A. General: Railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

Retain only those requirements in three subparagraphs below that apply to materials specified in Part 2.

1. Aluminum: The lesser of minimum yield strength divided by one and sixty-five hundredths (1.65) or minimum ultimate tensile strength divided by one and ninety-five hundredths (1.95).
2. Stainless Steel: Sixty percent (60%) of minimum yield strength.

3. Steel: Seventy-two percent (72%) of minimum yield strength.

B. Structural Performance: Except bridge railings, provide all other types of railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

Subparagraphs and associated subparagraphs below are examples only and are based on typical requirements of model codes. For some occupancy categories under certain circumstances, model codes have less-stringent provisions; revise to suit Project and to comply with requirements of authorities having jurisdiction.

1. Handrails:

   a. Uniform load of fifty (50) lb/ft applied in any direction at the top and to transfer this load through the supports to the structure.
   b. A single concentrated load of two hundred (200) lb/ft applied in any direction at any point along the top and have attachment devices and supporting structure to transfer this loading to appropriate structural elements of the building.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Top Rails of Guards:

First option in first subparagraph below applies to 1996 and 1999 BOCA Code, 2000 International Building Code, and 1997 Uniform Building Code; second option applies to 1993 BOCA Code.

   a. Uniform load of fifty (50) lb/ft applied horizontally and concurrently with 100 lb/ft applied vertically downward.
   b. Concentrated load of two hundred (200) lb/ft applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

3. Bridge Railings:

   a. For bridge railings, provide railings capable of withstanding the effects of loads as per the latest AASHTO requirements.

Delete two paragraphs and associated subparagraph below if only interior railings are required.

C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

Differential values in subparagraph below (for aluminum in particular) are suitable for most of the U.S.; revise to suit local conditions.

1. Temperature Change (Range): one hundred twenty degrees (120°) F, ambient; one hundred eighty degrees (180°) F, material surfaces.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Product Data: Delete first subparagraph below if mechanically connected railings are not specified.

1. Manufacturer's product lines of mechanically connected railings.
2. Grout, anchoring cement and paint products.

B. Shop drawings: Include plans, elevations, sections, details and attachments to other work.

Retain subparagraph below if products are required to withstand specific design loads and design responsibilities have been delegated to Contractor or if structural data are required as another way to verify products' compliance with performance requirements. Professional engineer qualifications are specified in Division 1 Section "Quality Requirements."

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for the preparation.

Delete paragraph below if colors, textures, and designs are preselected and specified or scheduled or if none are required.

C. Samples for initial selection: For products involving selection of color, texture, or design, including mechanical finishes on stainless steel.

Retain paragraph above or paragraph and subparagraphs below, or both, if required.

D. Samples for verification for each type of exposed finish required:

Delete or revise subparagraphs below to suit Project.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.

Usually delete subparagraph and associated subparagraph below except possibly for directionally finished stainless steel or mechanically connected aluminum.

3. Assembled sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
4. Show method of finishing and connecting members at intersections.

Usually delete paragraph below unless increased corrosion resistance of Type 316 stainless steel is required.

E. Mill Certificates: Signed by manufacturers of stainless steel products certifying that products furnished comply with requirements.

Retain paragraph below if procedures for welder certification are retained in "Quality Assurance" Article.

F. Welding certificates.

Paragraph below may be used for verification of performance requirements if authorities having jurisdiction do not allow Contractor to provide engineering calculations.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing through one (1) source from a single manufacturer.

Delete paragraph and subparagraphs below if no welding. Retain "Welding certificates" Paragraph in "Submittals" Article if retaining below. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

B. Welding: Qualify procedures and personnel according to the following:

Retain applicable standards below.

1. AWS D1.1, "Structural Welding Code—Steel."
2. AWS D1.2, "Structural Welding Code—Aluminum."
3. AWS D1.6, "Structural Welding Code—Stainless Steel."

1.6 PROJECT CONDITIONS

If possible, design railings so that they do not have to fit other construction, and delete this Article.

A. Field Measurements:

1. Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on shop drawings.

B. Established Dimensions:

1. Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts

and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.2 ALUMINUM RAILING

A. Aluminum alloy rails, splices and clamp bars shall conform to B 221, Alloy 6061, T6. Unless otherwise specified, the rails shall be supplied with a mill finish. Rails and splices may meet the requirements of B 221, Alloy 6351 T5 for chemical composition only.

B. Aluminum alloy rail end plates shall conform to B 209, Alloy 6061, T6. Cast rail end caps shall conform to B 108, Alloy SG70A , S5A and S7A for chemical composition only.

C. Extrusions for railing posts (including bases) shall conform to B 221, Alloy 6061, T6. Posts shall have a mill finish except that any sawed surfaces shall have a finish comparable to two hundred fifty (250) micro-inches. Bottom of post bases shall be thoroughly coated with a bituminous paint meeting the requirements of MIL-P-6883.

D. Material for anchor plates shall be steel conforming to A 709, Grade 36.

E. Anchor Studs shall conform to the following:

1. Stainless steel anchor studs shall conform to A276, Type 304, annealed, hot finished, ultimate strength seventy thousand (70,000) psi minimum twenty percent (20%) Min. Elongation.
2. Threads may be rolled or cut.

F. Material for heavy hex nuts shall conform to B 211, Alloy 6061 T6 or Alloy 6262 T9.

G. Material for steel nuts shall conform to A 307.

H. Material for aluminum washers shall be ALCLAD meeting the requirements of B 209, Alloy 6061 T6 or 7075 T6.

I. Material for rivets shall conform to B 316, Alloy 6061 T6 and Alloy 6053 T61 for chemical composition only and shall conform to Military Specification MIL-R-1150 in all other respects. The rivets shall be button head and cone point and shall be cold driven.

J. Material for clamp bar bolts and cap screws shall be stainless steel and conform to A 193, identification symbol B8.

K. Material for pins shall conform to B211, Alloy 6061 T6 and pins shall be press fit.

L. Weld metal for the welded base plate shall be 5356 A-1.

2.3 STEEL RAILING

A. Rail elements shall meet requirements of A501 for hot-formed welded and seamless carbon steel square, rectangular, or special shape structural tubing.

B. Round rail elements shall meet requirements of A53 for hot-formed welded and seamless steel pipe.

C. Steel plates, shapes and bars shall conform to A 36.

D. Gray iron castings shall conform to A48, Class 30, unless another class is indicated or required by structural loads.

E. Malleable iron castings shall conform to A47.

F. High tensile strength steel anchor bolts, nuts and washers shall conform to A325.

G. Wedge bolts conform to A307.

H. Galvanizing shall be performed in accordance with A 123.

I. Certifications for compliance with the above Specifications shall be furnished to the Engineer.

2.4 STAINLESS STEEL RAILING

Retain material types, qualities, and grades in this Article that are indicated in Specifications or on Drawings. Type 304 stainless steel is usually standard; Type 316 or 316L provides better corrosion resistance in coastal environments. If welding is required, Type 316L should be used instead of Type 316.

A. Tubing: ASTM A 554, Grade MT 304

Primary difference between round stainless-steel tubing and stainless-steel pipe is in outside dimensions. Pipe sizes are normally indicated by use of nominal pipe size designator and weight class or schedule number; for tubing, OD and wall thickness are used. See Evaluations.

B. Pipe: ASTM A 312, Grade TP 304

Retain first option in first paragraph below with Type 304; second option, with Type 316 or 316L.

C. Castings: ASTM A 743, Grade CF 8 or CF 20

D. Plate and Sheet: ASTM A 666, Type 304

E. Expanded Metal: ASTM F 1267, Class 3 (corrosion-resistant steel), made from stainless-steel sheet complying with ASTM A 666, Type 304

Style designations in subparagraph below indicate size. 3/4 number 13 has openings approximately 3/4 by 1-1/2 inches (20 by 40 mm) and is 0.09 to 0.10 inch (2.3 to 2.5 mm) thick; 1-1/2 number 10 has openings approximately 1 by 2-1/2 inches (25 by 65 mm) and is 0.13 to 0.142 inch (3.3 to 3.6 mm) thick.

F. Fasteners: Type 304 stainless steel fasteners.

2.5 FASTENERS

A. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

B. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

Delete subparagraph above or below. Above is more restrictive than below

2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

Delete subparagraph below or revise if another type of head is required or is standard with system selected.

3. Provide Phillips, tamper-resistant or square or hex socket flat-head machine screws as specified for exposed fasteners.

Delete paragraph below if not applicable. If retaining, select acceptable types and verify safety factors with Project's structural engineer.

C. Anchors: Provide cast-in-place, chemical or torque-controlled expansion anchors as specified, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and equal to four (4) times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS Specifications for metal alloy welded.

Delete subparagraph below if aluminum railings are not used or are not welded.

1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength and compatibility in fabricated items.

B. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

VOC limit in optional text below is the EPA limit for rust-preventive architectural coatings.

1. Use primer with VOC content of three and five-tenths (3.5) lb/gal or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Retain above for nonproprietary or below for semiproprietary specification. Refer to Division 1 Section "Product Requirements."

Delete paragraph below if galvanized railings are not shop primed.

C. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated and complying with SSPC-Paint 5.

Retain first paragraph below for galvanized railings that are not shop primed.

D. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

Select one or both paragraphs and associated subparagraph below to suit Project.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

Retain subparagraph below if railings are used at exterior or wet locations.

1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately one thirty-second inch (1/32″), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with either welded or nonwelded connections, unless otherwise indicated.

Delete paragraph and subparagraphs below if only nonwelded connections are acceptable or are compatible with metals and finishes retained. Connections below are generally applicable to exposed welding of steel and stainless steel.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

First paragraph below describes CraneVeyor's system.

I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

*Subparagraph below is an alternative to concealed mechanical fasteners and fittings*Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

K. Form changes in direction as follows:

Retain one of five subparagraphs below.

1. As detailed.

Retain one of three subparagraphs below if bending is used. First subparagraph allows fabricator to choose radius of bends. Second is for flush (zero-radius) bends. Third is for radii that are shown on Drawings.

2. By bending or by inserting prefabricated elbow fittings.
3. By flush bends or by inserting prefabricated flush-elbow fittings.
4. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

Retain subparagraph and one of three options below if bending is not used. First option allows fabricator to choose radius of fittings. Second is for flush (zero-radius) fittings. Third is for radii that are shown on Drawings

5. By inserting prefabricated elbow fittings or flush-elbow fittings or elbow fittings of radius indicated.

Retain first paragraph below unless all bends are made with elbow fittings.

L. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking or otherwise deforming exposed surfaces of components.

M. Close exposed ends of railing members with prefabricated end fittings.

N. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is one quarter inch (1/4″) or less.

O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

Retain subparagraph below if any railings are supported from plaster or gypsum board walls.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide fillers made from crush-resistant material or other means to transfer wall loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

Delete paragraph below if no posts are set in concrete or if posts are set without sleeves.

Q. For railing posts set in concrete, provide steel sleeves not less than six inches (6″) long with inside dimensions not less than one-half inch (1/2″) greater than outside dimensions of post, with steel plate forming bottom closure.

Delete first paragraph and subparagraph below if not required or if not allowed by authorities having jurisdiction.

R. For removable railing posts, fabricate slip-fit sockets from steel or stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth (1/40) of post height. Provide socket covers designed and fabricated to resist being dislodged.

1. Provide chain with eye, snap hook and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

S. Expanded-Metal Infill Panels: Fabricate infill panels from expanded metal made from same metal as railings in which they are installed.

1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than four hundred twenty-eight ten thousandths inch (0.0428″) thick.
2. Orient expanded metal with long dimension of diamonds as indicated.

Coordinate selection in subparagraph below with wire mesh pattern selected.

Retain paragraph below if required for protection against objects falling over edge of traffic surfaces. Delete if curb or other construction under rail satisfies toe-board requirement. Indicate locations, dimensions, and details on Drawings.

T. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

Delete paragraph below if no mechanical finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

Delete paragraph below if no variable finishes, such as color-anodized aluminum, are used.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half (1/2) of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

Retain paragraph below if exposed fasteners are allowed, especially with color anodic finish.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

Retain or revise finishes below to suit Project. If retaining more than one, indicate location of each on Drawings or by inserts. Revise mechanical finish if custom finish is required and availability is verified.

B. Mechanical Finish: AA-M12 (Mechanical Finish: nonspecular as fabricated).

C. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

Above is standard finish with many manufacturers; below is heavy-anodized finish. Verify availability with manufacturers selected.

D. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating eighteen hundredths (0.018) mm or thicker) complying with AAMA 611.

E. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating eighteen hundredths (0.018) or thicker) complying with AAMA 611.

Retain one color below if color anodic finish is retained above.

Options in subparagraph above are examples only and may vary in color range and availability among manufacturers. Retain one or delete all and retain one of two options in subparagraph below.

1. Color: As selected by the Engineer from full range of industry colors and color densities.

Paragraph below references AAMA standards for high-performance and superior performance organic coatings on extrusions and panels. Revise if specific products are required.

F. High-Performance Organic Finish (two (2) Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard two (2) coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than seventy percent (70%) polyvinylidene fluoride resin by weight). Prepare, pretreat and apply coating to exposed metal surfaces to comply with AAMA 2604 or AAMA 2605 and with coating and resin manufacturers' written instructions.

Delete paragraph above or below; if both are required, indicate location of each system on Drawings, in schedules, or by inserts. Paragraph below references AAMA standard for superior-performance organic coating on extrusions and panels; revise if specific products are required.

G. High-Performance Organic Finish (three (3) Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard three (3) coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than seventy percent (70%) polyvinylidene fluoride resin by weight). Prepare, pretreat and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

Retain one color and gloss below with either paragraph above.

1. Color and Gloss: As selected by the Engineer from manufacturer's full range.

For exact finish, insert names of coating manufacturers and products

2.10 STAINLESS STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

Delete paragraph below if no directionally textured finishes are retained.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

Finish in paragraph below is similar to No. 4 finish but has a slightly finer texture.

C. 180-Grit Polished Finish: Oil-ground, uniform, directionally textured finish.

Finish in paragraph below has a finer texture than finish above.

D. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.

Finish in paragraph below is similar to No. 7 finish.

E. Polished and Buffed Finish: Oil-ground, 180-grit finish followed by buffing.

Select one of last three paragraphs above or one of first two paragraphs below. Standard mill-applied finishes above are for ornamental tubing; sheet finish designations below are frequently used to specify finishes applied after fabrication. Insert others as required after verifying availability with manufacturers selected. See Evaluations.

Finish in paragraph below is 120 to 150 grit.

F. Directional Satin Finish: No. 4.

Finish in paragraph below is a nondirectional finish produced from a No. 4 finish by brushing with an extremely fine abrasive to remove the grit lines without producing a reflective appearance.

G. Dull Satin Finish: No. 6.

H. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.11 STEEL AND IRON FINISHES

Retain paragraph and subparagraphs below if any steel and iron railings are galvanized.

A. Galvanized Railings:

Select subparagraph above or first subparagraph below. Select above and delete "exterior" option if all railings, both interior and exterior, are galvanized. Select below if only certain steel and iron railings are galvanized; indicate locations of galvanized railings on Drawings.

1. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
2. Comply with ASTM A 123 for hot-dip galvanized railings.
3. Comply with ASTM A 153 for hot-dip galvanized hardware.

Usually retain first paragraph below for railings hot-dip galvanized after fabrication.

B. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

D. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux and other foreign matter, and treat with metallic-phosphate process.

Retain paragraph above for shop-primed galvanized railings, first paragraph and subparagraphs below for nongalvanized railings.

F. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation Specifications and environmental exposure conditions of installed railings:

Retain one or more of three subparagraphs below to suit Project service conditions of installed work. Insert other exposures and preparation requirements where applicable. Refer to SSPC's painting manual. Two subparagraphs below apply to locations that would normally remain dry in service.

1. Exterior Railings (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Interior Railings (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

Delete subparagraph above and option in subparagraph below if all interior railings are to receive zinc rich primer.

3. Interior Railings indicated to receive zinc rich primer (SSPC Zone 1A): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

G. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

Delete subparagraph below if galvanized railings are shop primed.

1. Do not apply primer to galvanized surfaces.

Delete subparagraph below if not required. Stripe painting adds cost but helps ensure that hard-to-reach areas, such as crevices, inside corners, and welds, are thoroughly coated and that sharp edges (which are vulnerable to chipping and are where the film may be thinner due to surface tension) receive adequate coverage.

2. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 EXECUTION

3.1 STORAGE AND HANDLING OF MATERIALS

A. Metal railing and incidental parts shall be carefully handled and stored on blocking racks or platforms so as not to be in contact with the ground and shall be protected from corrosion and/or other damage. Materials shall be kept free from dirt, oil, grease, and other foreign matter. Surfaces to be painted shall be carefully protected both in the shop and in the field. Bent, broken and damaged material will be rejected by the Engineer or it may, at its discretion, permit its repair and use.

B. Proper production and shipping methods shall be used to avoid marking, denting, or scratching aluminum and/or galvanized steel components. No wire or metal straps shall be used to package or bundle aluminum and/or galvanized steel components for shipment; use twine, rope, paper, or crating.

3.2 EXAMINATION

Delete this Article if no handrails are attached to plaster or gypsum board assemblies.

Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for installer. Locate reinforcements and mark locations if not already done.

3.3 GENERAL INSTALLATION

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling and fitting required for installing railings. Set railings accurately in location, alignment and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of one-sixteenth inch (1/16″) in three feet (3′).

Revise subparagraph above and below if closer tolerances are required. Both are from NAAMM's "Pipe Railing Systems Manual."

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed one-quarter inch (1/4″) in twelve feet (12′).

Delete first paragraph below if no aluminum.

C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood or dissimilar metals, with a heavy coat of bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

F. Rails shall be parallel to the grade of the roadway.

G. Rail sections shall be securely attached to each post, and a minimum of three (3) posts shall be provided (unless indicated otherwise on the Contract Drawings).

H. Posts shall be set perpendicular to the top of parapet and shall be spaced as indicated on the Contract Drawings (Maximum eight foot (8′-0″) spacing).

I. The centerline of any splice and/or expansion joint shall be located at least two feet (2′-0″±) away from the centerline of a post, except where indicated on plans. Expansion and/or splice joints for each strand of two (2) strand railing shall be placed in the same location and in the same panel.

J. After the Work has been completed and approved by the Engineer, all parts shall be thoroughly cleaned in a manner acceptable to the Engineer.

K. No steel wool or abrasive cleaners shall be used on aluminum or galvanized parts, unless directed by the Engineer.

L. Bridge Rail Post: In order to insure good grade and alignment on structural steel spans railing posts shall not be erected nor railing connections made until after the concrete for

the deck and sidewalk has been placed and cured. Posts for railings on concrete spans shall not be erected until after the forms, falsework and centering supporting the concrete have been removed. Where railing is fitted between concrete posts, it shall be fabricated so as to provide proper means for inserting and erecting panels.

3.4 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

Delete paragraph above or below unless both methods are required. If both mechanical and welded connections are required, indicate locations of each on Drawings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections whether welding is performed in the shop or in the field.

Delete paragraph below if no expansion joints are required or revise to suit Project. Indicate locations on Drawings based on temperature changes expected and coefficient of expansion of metals involved.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending two inches (2″) beyond joint on either side, fasten internal sleeve securely to one side and locate joint within six inches (6″) of post.

3.5 ANCHORING POSTS

Select type(s) of anchorage in this Article to suit Project.

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

Retain paragraph above or first paragraph below, or delete both if no posts in concrete. Coordinate with products selected in Part 2.

B. Form or core-drill holes not less than five inches (5″) deep and three-quarters inch (3/4″) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material or attached to post with set screws as directed by the Engineer.

Retain paragraph above or below if retaining either concrete anchorage method above.

D. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave one-eighth inch (1/8″) buildup, sloped away from post.

Revise paragraph below if posts are welded directly to supports.

E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

Retain one of three subparagraphs below. Welded and bolted connections of aluminum should be specially detailed.

1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
2. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
3. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

Delete paragraph below if not applicable.

F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.6 ANCHORING RAILING ENDS

Delete this Article if railing ends are not anchored.

A. Anchor railing ends to concrete and masonry with round flanges connected to railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections as directed by the engineer.

3.7 ATTACHING HANDRAILS TO WALLS

Revise first paragraph below if end return fittings are also used to support handrails.

A. Attach handrails to wall with wall brackets. Provide brackets with one and one-half inch (1-1/2″) clearance from inside face of handrail and finished wall surface.

1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.

Retain subparagraph above or below.

2. Use type of bracket with predrilled hole for exposed bolt anchorage.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

Revise paragraph below if end return fittings are also used to support handrails.

C. Secure wall brackets to building construction as follows:

Delete three subparagraphs below if not applicable or revise to suit Project.

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.

Select one of three subparagraphs below if steel studs are used. Wood blocking may not be allowed in fire-resistance-rated partitions.

4. For steel-framed gypsum board or plaster partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed gypsum board or plaster partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.
6. For steel-framed gypsum board or plaster partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.8 ADJUSTING AND CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

Retain paragraph above if touchup painting is included in this Section. Retain paragraph below if it is specified in Division 9 painting Sections. Revise reference if another Division 9 Section, such as "High-Performance Coatings," is used.

C. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in section 09 97 13.24, (Cleaning and Painting Existing Structural Steel).

Delete paragraph below if no galvanized materials.

D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.9 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of substantial completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

PART 4 MEASUREMENT AND PAYMENT

A. Method of Measurement

This item will be measured by one of the following methods and the Proposal will indicate which method is applicable in each case.

1. Method 1: The item will not be measured but will be included in the Work to be done under a unit or lump sum price bid for another item.
2. Method 2: The item will not be measured but will be paid for on the basis of a lump sum for all metal railing on the project, or on the basis of a lump sum for all metal railing on each structural unit.
3. Method 3: The item will be measured for the actual number of linear feet of metal railings, satisfactorily completed and accepted, computed from measurements taken parallel to the base or foundation upon which railings are supported, unless otherwise shown on the Plans.

B. Basis of Payment

1. Method 1: Unless a pay item for "Metal Railing" is specifically set up in the Proposal, this item will not be paid for as such but its costs will be included in the Contract Price for another item.
2. Method 2: When the Proposal includes a pay item for "Metal Railing" the item will be paid for on the basis of the Contract lump sum price for "Metal Railing" complete in place and such payments shall be full compensation for all labor, material, equipment and incidentals, including the furnishing, erecting, anchoring, galvanizing, and painting of the railing as necessary to complete the item in accordance with the provisions of the Plans and Specifications.
3. Method 3: The item will be paid for on the basis of Contract Unit Price per linear foot for "Metal Railing" complete in place and such payment shall be full compensation for all labor, materials, equipment and incidentals, including the furnishing, erecting, anchoring, galvanizing and painting of the railing as necessary to complete the item in accordance with the provisions of the Plans and Specifications.

DIVISION 06
WOOD, PLASTICS, AND COMPOSITES
06 10 00 ROUGH CARPENTRY

06 10 53 MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL
1.1 DESCRIPTION

A. This Work shall consist of constructing structures or portions of structures using timber, including fabrication, erecting, treating and coating of the timber elements as specified in the Contract Documents or as directed by the Engineer.

B. For timber piling refer to 31 62 00, (Driven Piles). For structural steel refer to "Structural Steel Framing" 05 12 00, (Structural Metal Framing-metal Structures). For concrete refer to 03 30 00, (Portland Cement Concrete Structures).

PART 2 PRODUCTS

2.1 MATERIALS

A. Asphalt Cement: The manufacturer and hauler shall furnish certifications of the following:

1. Date and time of loading.
2. Tank or blending system.
3. Identification of hauling unit.
4. Binder grade, temperature, and quantity of materials.
5. Complete certified analysis.
6. Lot number, if applicable.
7. Mixing and compaction temperatures when the binder is polymer modified.
8. The hauler shall also certify:

    a. Identification of hauling unit
    b. Binder grade and source of last delivery
    c. The date of the last delivery using this hauling tank and volume of material remaining in the tank at the time of current loading

9. The certificate shall verify that the material and Work complies with the applicable specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

B. Structural Steel: Structural steel shall conform to the requirements specified in the Contract Documents. All primary load-carrying members shall conform to the supplementary toughness requirements of M 270, Zone 2.

C. Gray Iron Castings: Iron castings shall conform to A 48, Class 30B.

D. Bolts and Hardware: Spikes, wood screws, staples, brads, lag screws, carriage bolts, and other parts under the general heading of "Hardware" shall be composed of carbon steel and shall conform to Federal Specification FF-N-105.

E. Structural Timber: Structural timber and lumber shall conform to M 168.

The manufacturer shall furnish certification stating that the material complies with the applicable specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the manufacturer's letterhead or approved document and shall be duly signed by a company officer.

F. Preservative Treatments for Timber: Preservatives and pressure treatment for timber shall conform to M 133.

G. Metal Timber Connectors: Per manufacturer and approved by the Engineer.

H. Galvanizing shall conform to A 153.

I. Fire Stops and Galvanized Sheet Metal shall conform to A 653, Coating Designation G 90.

J. Paint: Paint shall conform to the requirements of "Paints" 09 97 13.23, (Cleaning and Painting New Structural Steel).

PART 3 EXECUTION

3.1 STORAGE AND HANDLING

A. Timber shall be stacked in piles at least twelve inches (12″) above the ground surface in a manner to shed water and prevent warping. It shall be protected from weather by a suitable covering. The storage site shall be cleared of weeds and rubbish before placing material and throughout the storage period. The site selected shall not be subject to flooding. Timber shall be handled with rope or nylon slings to prevent the breaking of outer fibers, bruising, or penetrating the surface.

B. Untreated material shall be open stacked, and treated material shall be close stacked.

3.2 CUTTING AND BORING

A. When practical, cutting and boring of treated timbers shall be done before pressure treatment with preservatives. All cuts in treated timbers and all abrasions (after having been carefully trimmed) shall be brush coated with two (2) applications of an approved wood preservative before installing the timber in the structure. When the Engineer determines that treated timbers are damaged beyond repair, they shall be removed from the project and replaced at no additional cost to the City.

B. When forms or temporary braces are attached to treated timber with nails or spikes, the holes shall be filled by driving galvanized nails or spikes flush with the surface, as directed by the Engineer.

3.3 BOLT HOLES

Bolt holes bored after treatment shall be filled with asphalt cement applied with a caulking gun or as directed by the Engineer before inserting bolts. Holes that are not to receive bolts shall be plugged with asphalt cement coated plugs.

3.4 COATING UNTREATED SURFACES

In untreated timber structures, all contact surfaces between any members (except adjacent flooring members) shall be coated with two (2) coats of an approved preservative before assembling. The back faces of bulkheads and all surfaces of timber that will come in contact with earth, metal, or other timber shall be similarly coated. The ends of timber members shall be coated in the same manner.

3.5 PROTECTION OF ENDS OF CAPS, WALES, AND PLANKS

A. The ends of all caps, wales, and planks shall be covered with resin glass composite shields as approved by the Engineer. The shields shall be applied as follows:

1. Remove all dirt and other loose material from area to be capped.
2. Apply the first coat of resin to the top and four inches (4″) down the side of the member.
3. Apply precut glass cloth, using a three inches (3″) grooved aluminum roller to achieve "wet-out" and brass staples for anchorage.
4. When the initial coat of resin has taken a tack free set, apply a second coat of resin to seal the entire application.

3.6 DIAMETER OF HOLES

A. Holes bored in timber structures shall conform to the following:

1. Round drift bolts, spikes, and dowels — one-sixteenth inch (1/16″) less than the diameter of the device.
2. Square drift bolts, spikes, and dowels — equal to the smallest dimension of the device.
3. Machine bolts — same as the diameter of the bolts.
4. Rods — one-sixteenth inch (1/16″) larger than the diameter of the rods.
5. Lag screws — equal to the diameter of the screw at the base of the thread.
6. Connector bolts — one-sixteenth inch (1/16″) larger than the diameter of the connector bolts.

3.7 BOLT ASSEMBLIES

Bolt heads or nuts, which come in contact with the timber, shall be fitted with a washer of the size and type specified. After all nuts are adequately tightened, the bolt threads shall be burred.

3.8 COUNTERSINKING

Countersinking shall be done wherever smooth faces are required. In treated timber, recesses formed in horizontal surfaces for countersinking shall be painted with an approved preservative. After the bolt or screw is in place, recesses shall be filled with an approved asphalt coating.

3.9 CONNECTORS

Connector holes shall be bored through members to be connected. The bolt hole shall be kept perpendicular to the face of the timber. When spike grids or split ring connectors are specified in the Contract Documents, they shall be installed in conformance with the manufacturer's recommendations.

3.10 FRAMING

All timber shall be accurately cut and framed to provide even bearing over the entire contact surface, when making joints; shimming and open joints are prohibited.

3.11 SILLS

Sills shall have true and even bearing on mudsills or concrete pedestals. All earth shall be removed from contact with sills.

3.12 TIMBER CAPS

Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift bolts or as specified in the Contract Documents. The drift bolts shall be in the center of the post or pile.

3.13 BRACING

The ends of bracing shall be bolted through the pile, post, or cap. Intermediate intersections shall also be bolted. Spikes or nails shall be used in addition to bolts. When bracing intersects, filler blocks shall be used with a bolted connection.

3.14 STRINGERS

A. Stringers shall be placed in position so that knots near edges will be in the top portions of the stringers. Bottom edges of stringers shall be sized to provide uniform depth at bearings.

B. Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated a minimum one-half inch (1/2″) and shall be securely fastened by drift bolts where specified. When stringers are two (2) panels long, the joints shall be staggered.

C. Cross bridging between stringers shall be toe nailed with at least two (2) nails in each end. The lower ends of all bridging and one (1) side of each diaphragm shall be left disconnected and free to move until after the deck above it has been securely fastened to the stringers.

3.15 FLOOR PLANKING

Floor planking shall, unless otherwise specified, be SIS and SIE, hit or miss, and the planks shall be of uniform thickness with a maximum tolerance of one-eighth inch (1/8″). Where necessary to maintain traffic, planks shall be laid in half-of-bridge width sections.

Timber plank floors shall always be accompanied with suitable hold down devices. Planks shall be spiked to every stringer or joist or nailer using not less than two (2) spikes, and the length of the spikes shall be at least equal to twice the thickness or depth of the plank. Where planks will be under wheel guards or hold down devices, care shall be taken while selecting planks of as near equal thickness as possible. Before any hold down or wheel guard is bolted, treated shims or wedges shall be firmly driven between low planks and hold down and low planks and wheel guard so that all planks shall be held down with equal pressure. The shims shall occupy at least fifty percent (50%) of the area between the bottom of the hold down and the top of the plank and between the bottom of the wheel guard and the top of the plank.

3.16 BRIDGE RAILINGS AND WHEEL GUARDS

A. Bridge railings shall conform to performance level 1 (PL-1) as specified in the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Railings. All dimensions for timber rail, posts, and spacers shall be the actual dimensions of the timber.

B. Bridge rail and wheel guard splices shall be located so that rail and guard members are continuous over a minimum of two (2) posts. Bridge railings and wheel guards shall be installed in sections not less than twelve feet (12′) long. Splices shall be ship lapped with the lap equal to eight inches (8″) or the greater side of the piece, whichever is larger.

C. Painting: Rails and rail posts, untreated timber, or timber treated with a preservative shall be painted with three (3) coats of paint. Metal parts, except hardware, shall be given one (1) coat of shop paint and, after erection, three (3) coats of field paint.

PART 4 MEASUREMENT AND PAYMENT

A. Piles are excluded. The payment will be full compensation for all timber (treated or untreated) storage and handling, preservative, composite shields, asphalt cement, metal components, drilling holes, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Timber structures will be measured and paid for at the Contract Unit Price per one thousand (1000) board feet "MBM." The computation of quantities will be based on the nominal sizes specified in the Contract Documents and the exact overall net length of pieces remaining in the completed structure. No allowance will be made for waste. If a lump sum Contract has been agreed to, the timber structures will not be measured.

C. Painting timber structures, when a pay item, will be paid for at the Contract lump sum price. When not a pay item, the cost thereof shall be included in the price for other appropriate pay items.

DIVISION 09
FINISHES

09 96 00 HIGH PERFORMANCE COATINGS

09 96 56 EPOXY COATINGS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and applying epoxy protective coatings as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sand: Sand shall conform to Division 31 62 13.21, (Protective Jackets for Piles), paragraph 2.1 A.

B. Epoxy Protective Coatings: The protective coatings shall be two (2) component epoxy systems for use in conjunction with concrete. One (1) component shall be a clear or pigmented condensation product of the reaction of epichlorohydrin with bisphenol A, the resin of which shall be composed of one hundred percent (100%) reactive constituents. The other component shall be a clear polyamide hardener. The producer shall submit a sample of each component for laboratory analysis. The sample shall be coded as the original sample. The original and all subsequent samples shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Pot Life, hr min	Fed. Spec TT-C-535	8
Color	Fed. Standard 595	Gray No. 26440
Dry Film Thickness 1st coat, mil min 2nd coat, mil min	D 1005	 2 3
Sagging	D 4400	Must pass test for recommended film thickness
Flexibility	Federal Spec TT-P-115	Must not crack, check or delaminate
Infrared Spectrogram	Equipment Manufacturer's Procedure	Each component shall match original sample
Tensile Strength, psi min	MSMT 609	400

PART 3 EXECUTION

2.2 GENERAL

The epoxy protective coating shall not be applied until at least thirty (30) days after forms are removed. All surfaces to be coated shall be abraded by abrasive blasting, water blasting, or other mechanical means to provide a surface profile for improved adhesion.

The surface shall be sound, clean, thoroughly dry and free of oil, grease, curing compound, and other foreign matter before applying the first epoxy protective coating. Two (2) coats shall be applied to the specified areas of the structure. The application of each epoxy protective coating shall follow a dry weather period of at least two (2) consecutive days and within the time frame recommended by the manufacturer. Adjacent areas not to be coated shall be masked or otherwise protected to prevent staining.

2.3 MIXING AND APPLICATION

Mixing and application shall conform to the manufacturer's recommendations. Epoxy coatings shall be applied by brush or roller. Epoxy coatings shall not be applied to piers and abutments until the structural steel masonry plates have been placed.

2.4 COATING REQUIREMENTS

A. The second epoxy coating on the top surfaces of the piers and abutment bridge seat areas between beam pads shall be sprinkled with an excess of sand while it is still wet. When it has hardened sufficiently to resist marring, the excess sand not adhering to the coatings shall be removed. Areas to be coated are:

B.

1. Abutments that are under a transverse joint in the deck shall be coated. The coatings shall be applied to the entire horizontal surface of the abutment bridge seat areas (between and around the beam pads) and all exposed surfaces of the beam pads, and the entire contiguous vertical faces of the backwalls and cheek walls.
2. Piers that are under a transverse joint in the deck shall be coated. The coatings shall be applied to the entire horizontal surface of pier bridge seat areas (between and around the beam pads), and all exposed surfaces of the beam pads.
3.

2.5 MATERIAL PRECAUTIONS

The manufacturer's Material Safety Data Sheet shall be used in handling and use of the material.

2.6 REPAIRS

Any portion of the structures damaged by the Contractor's operations in applying the protective coatings, including damage to the epoxy protective coating, shall be repaired as directed by the Engineer, at no additional cost to the City. Epoxy protective coating repairs shall be performed in conformance with the manufacturer's recommendations.

PART 3 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for coats and all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Epoxy protective coatings for concrete for which no specific item is included in the Contract Documents will not be measured but the cost will be incidental to other pertinent items included in the Contract Documents.

C. Epoxy protective coatings for concrete will not be measured but will be paid for at the Contract lump sum price for the pertinent Epoxy Protective Coating item.

D. Epoxy protective coatings for concrete will be measured and paid for at the Contract Unit Price per square yard for the pertinent Epoxy Protective Coating item.

09 97 00 SPECIAL COATINGS

09 97 13.23 EXTERIOR STEEL COATINGS (CLEANING AND PAINTING NEW STRUCTURAL STEEL)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of cleaning and painting new structural steel to be used for work such as new construction, deck widening, and repairs requiring the installation of new structural steel. When the existing steel is not scheduled for repainting, this Work shall also consist of repairing existing coatings damaged during the Contractor's operations, and where new steel ties into existing steel. When the existing steel is scheduled for repainting, the Work shall conform to 09 97 13.24, (Cleaning and Painting Existing Structural Steel). When the new or existing steel are prepared by abrasive blast cleaning in the field, the containment and environmental monitoring requirements of 09 97 13.24, (Cleaning and Painting Existing Structural Steel) shall apply.

1.2 AREAS TO BE COATED

A. Areas of shop cleaning and priming; and field cleaning and painting shall involve the following surfaces:

1. Nonweathering Steel — All surfaces.
2. Weathering Steel.

a. The outside facing surfaces of the fascia stringers for all structures over roadways and for structures over water that contain curb openings. For dual structures this includes the outside facing surfaces of the median fascia. Outside facing fascia surfaces are those surfaces that face away from the structure. These surfaces include the underside of the top flange, the web facing away from the structure, the top of the bottom flange, the outside edge of the bottom flange, the underside of the bottom flange, the inside edge of the bottom flange and the top of the bottom flange on the inside facing surface up to and including the fillet weld. A sharp well defined the transition between the new painting on the flange and the bare steel above the fillet will not be required. Overspray onto the web is acceptable. All attached bearings are included in the cleaning and painting.

b. At abutments, the end ten feet (10′) of all stringers and all other structural steel within the ten foot (10′) area (e.g., stiffeners, cross bracing, bearings) etc.

c. At piers, ten foot (10′) in each direction from the center line of the pier giving a total length at each pier of twenty foot (20′) and all other structural steel within the area (e.g., stiffeners, cross bracing, bearings) etc.

d. At bolted field splices, twelve inches (12″) beyond the longest splice plate for each particular splice and all splice material.

1.3 GENERAL

A. The Work shall conform to SSPC Standards and to the manufacturer's recommendations unless otherwise approved by the Engineer.

B. Any structural defects including cracks, missing bolts or rivets, deterioration, etc., detected during cleaning and painting shall be brought to the attention of the Engineer. The field Contractor shall protect utility pipes, conductors, light fixtures, and conduits from these operations; they shall not be cleaned and painted unless specified in the Contract Documents.

C. The shop and field Contractors shall perform quality control (QC) inspections to ensure that each phase of the Work complies with Specification requirements.

D. All maintenance of traffic required for corrective action shall be at no additional cost to the City. When a railroad is included in the project, all railroad fees shall be as specified in the Contract Documents, except that any additional impact on the railroad and associated fees due to corrective actions or additional inspections shall be at no additional cost to the City.

E. The Contractor shall conform to the requirements of OSHA regarding lead, arsenic, cadmium, etc. exposure and the applicable Federal and State laws, as applicable.

F. Prior to bidding, the Contractor shall be familiar with the current environmental regulations and safety procedures. The City and the Contractors are considered "Co-Generators" of all waste associated with the Work not performed by a fabrication shop. When disturbing existing lead coatings, the Contractor shall prevent the waste from entering into the environment by containing, collecting, storing, testing and disposing of all waste in conformance with Federal, State and local regulations. When the new steel is prepared by abrasive blast cleaning in the field, all waste shall be collected and the containment and environmental monitoring requirements of 09 97 13.24, (Cleaning and Painting Existing Structural Steel) shall apply.

PART 2 PRODUCTS

2.1 MATERIALS

A. Paint Systems: All paint within the paint systems specified herein shall be from the same manufacturer. When more than one (1) paint system is used, all paint shall be from the same manufacturer. The color of the finish coat on new steel shall be as specified in the Contract Documents. The color of the touch up finish coat on existing steel shall match the existing finish coat.

1. New Steel (Includes New Structures, Repairs, or Widening): The paint shall conform to Paint System B. Touch up paint for the shop primer prior to Coats II and III shall conform to Coat I of Paint System C as approved by the coating manufacturer.
2. Existing coatings damaged due to steel/deck repairs or new connections: The paint shall consist entirely of spot coats of Coat I of Paint System H, and Coats II and III of Paint System B.
3. Bolts and Field Welds: All bolts and field welds shall be primed with Coat I of Paint System C prior to the application of Paint System B, Coats II and III.

4. Paint systems shall be as specified in the following Paint Systems Table.

PAINT SYSTEMS TABLE

PAINT	COAT	SECTION	DRY FILM THICKNESS, mils, min - max	USAGE
SYSTEM A				
Inorganic Zinc	I	912.02.01	3.0 - 5.0	Shop Primer
Acrylic	II	912.03.01	2.0 - 4.0	First Field Coat
Acrylic	III	912.04.01	2.0 - 4.0	Finish Coat
SYSTEM B				
Inorganic Zinc	I	912.02.01	3.0 - 5.0	Shop Primer
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	First Field Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat
SYSTEM C				
Organic Zinc	I	912.02.03	3.0 - 5.0	Primer/First Cover-All Coat
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	Second Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat
SYSTEM D				
Organic Zinc	I	912.02.03	3.0 - 5.0	Primer/First Cover-All Coat
Acrylic	II	912.03.01	2.0 - 4.0	Second Cover-All Coat
Acrylic	III	912.04.01	2.0 - 4.0	Finish Coat
SYSTEM E				
Aluminum Epoxy Mastic	I	912.02.02	5.0 - 8.0	Primer/First Cover-All Coat
Epoxy Polyamide	II	912.03.02	5.0 - 8.0	Second Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 - 3.0	Finish Coat
SYSTEM F				
Micaceous Iron Oxide, Aluminum Filled Moisture Cured Urethane	I	912.02.05	2.0 - 3.0	Primer/First Cover-All Coat
Micaceous Iron Oxide Moisture Cured Urethane	II	912.03.03	3.0 - 5.0	Second Cover-All Coat
Moisture Cured Aliphatic Urethane	III	912.04.03	1.5 - 2.0	Finish Coat

PAINT	COAT	SECTION	DRY FILM THICKNESS, mils, min - max	USAGE
SYSTEM G				
Zinc Rich Moisture Cured Urethane	I	912.02.04	2.0 - 3.0	Primer/First Cover-All Coat
Micaceous Iron Oxide Moisture Cured Urethane	II	912.03.03	3.0 - 5.0	Second Cover-All Coat
Moisture Cured Aliphatic Urethane	III	912.04.03	1.5 - 2.0	Finish Coat
SYSTEM H				
Penetrating Sealer	I	912.02.06	1.0 - 2.0	Sealer
Aluminum Filled Epoxy Mastic	II	912.02.02	3.0 - 5.0	Spot Coat
Aliphatic Urethane	III	912.04.02	3.0 - 5.0	Finish Coat

MOISTURE CURED URETHANES ADDITIONAL PERFORMANCE CRITERIA TABLE

TEST PROPERTY	TEST METHOD	TEST CRITERIA	COAT I & II	ENTIRE SYSTEM
Cyclic Salt Fog/UV Exposure of Painted Metal	D 5894	Final Ratings: Rusting: 6 min Blistering: 10 min Rust Creep: 6 max Cracking: Degree & Type Flaking: Degree & Type	1000 hr	3000 hr
Salt Spray	B 117	1/32 inch Scribe, /16 inch max undercut	1000 hr	3000 hr
Abrasion Resistance	D 4060	Taber Abraser, CS-17 Wheel, 1000 g load, 1000 cycles, max loss	100 mg	56 mg
Adhesion	D 3359	Cross-Cut Tape Test	No Peeling or removal	No peeling or removal
Flexibility	D 522	Conical Mandrel Bend Test, min elongation	10 %	40 %
Pencil Hardness	D 3363	min	F	F
Accelerated Weathering	G 53	QUV using UV - B Lamp, time after no more than 10 % loss of gloss	—	400 hr
Impact Resistance	D 2794	min	—	40 inch·lb
Chemical Resistance, Solutions	Fed. Spec. T-C-550 4.4.6	5 % Sodium Hydroxide 5 % Hydrochloric Acid 5% Sulfuric Acid 5 % Acetic Acid	—	Unaffected – Slight discoloration permitted
Reversed Impact	D 2794	Rapid Deformation	—	No cracking or delamination

B. Abrasives. Abrasive media used in blast cleaning operations shall result in blasted surfaces having a surface profile height of one and five tenths to four (1.5 to 4.0) mil as determined by a spring micrometer with surface profile replica tape. The Contractor shall provide material safety data sheets (MSDS) for the abrasives used and a letter from the abrasive supplier indicating that the expendable abrasives comply with SSPC AB-1 and the recyclable abrasives comply with SSPC AB-3. The cleanliness of recycled abrasives shall be verified in conformance with SSPC AB-2.

PART 3 EXECUTION

3.1 SUBMITTALS

A. The Contractor shall submit the following drawings, plans and information for accomplishing the Work to the Engineer for approval. Work is prohibited until the submittals are approved by the Engineer.

1. Personnel Qualifications. Provide applicable personnel qualifications to the Engineer prior to using the personnel on site. Refer to paragraph 3.2.
2. Quality Control (QC) Plans. Refer to paragraph 3.3 for detailed submittal requirements for shop and field quality control plans. Submittals shall conform to the following for shop Work and 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data) for field Work.

    a. All materials included herein will be sampled, tested and inspected as specified in the most recently published cited standards. The Specification limits for each material are established and no deviation from these limits will be permitted except when, in the judgment of the Engineer, the deviation will not be detrimental to the Work. In these cases, refer to the appropriate Specification governing price adjustments for nonconformance.
    b. Within 30 days after receipt of notification of award of the Contract, the Contractor shall submit in writing, to the Engineer, the sources from which the Contractor proposes to obtain all materials to be incorporated into the project. No material shall be introduced into the Work until approval of sources has been obtained. The City reserves the right to completely or partially test any material for Specification compliance.
    c. Sampling shall be as directed by the Engineer. All source approvals are made subject to continuing production of materials conforming to these Specifications. Material sources may be rejected where it is evident that the material tends to be of marginal quality when compared to the Specification limits in any of its specified properties.
    d. Unless otherwise specified, paint shall be tested in conformance with federal test method. Only one (1) formulation per color will be permitted per project. Tests shall be performed at seventy-five degrees (75°) F and 50 percent (50%) relative humidity unless otherwise specified. All paint shall be satisfactory for brushing, rolling or spraying. All paints within a system shall be from the same manufacturer and shall be tinted at the point of manufacture to differentiate between coats, existing coats, and bare metal. Paint shall be shipped in the original containers and all containers shall bear the identification of the paint, consisting of the manufacturer's name, the name or title of material, volume of contents, manufacturer's

paint identification number, the date of manufacture, color name and number, handling instructions, precautions and the batch number.

1) Quality Control Plan: The quality control plan shall define the manufacturer's process to ensure that the quality of the products during and upon completion of the manufacturing process. As a minimum, the quality control plan shall list the following information:

   a) Name of quality control tests and test procedures used.
   b) Detailed description of the test procedures if not a standard test.
   c) Frequency of quality control tests.
   d) Maintenance of quality control records and length of time that they will be maintained.

2) Acceptance: The paint manufacturer shall furnish certified test results for each lot and color of paint. Certified test results for each lot shall list the actual test results for the specified properties. The certification shall be approved by the Engineer prior to shipment, and a copy shall accompany each shipment.

3) Original Infrared Spectrogram: The manufacturer shall submit an original analysis of vehicle solids by infrared spectroscopy performed as specified in D 2621 as follows:

   a) For zinc primer coatings, infrared spectrum (2.5 to 15 μm) of each vehicle component.
   b) For two (2) component coatings, infrared spectrum (2.5 to 15 μm) of each single component and each mixed component, when applicable, in appropriate mixing ratios.

4) Certification Verification Tolerances: The manufacturer's facilities will be visited at random intervals and samples will be taken. A comparison will be made between the manufacturer's certified test results and the Engineer's tests results on the same batch. The tolerances between these results shall conform to the following:

TEST	TOLERANCE	TEST METHOD
Total Solids by mass, %	± 2	D 2369
Pigment Content by mass, %	± 2	D 2698 or D 4451
Vehicle Solids by mass, %	± 2	D 2369
Viscosity, KU	± 10	D 562
Unit Weight, lb/gal	±0.5	D 1475

Volatile Organic Compound (VOC) maximum limits shall conform to the current regulations governing the point of application.

3. Paint Manufacturer Certifications and Letters: The following information shall be submitted to the Engineer:

a. When detergents or additives are proposed to be incorporated into the water used for washing, the Contractor shall provide MSDS and a letter from the coating manufacturer that approves the use of the detergents with their coating.
b. The manufacturer shall provide a letter that approves any proposed solvents for use in solvent cleaning prior to painting or between coats. MSDS for the solvents shall be provided.
c. The paint manufacturer's application and thinning instructions, MSDS and product data sheets shall be provided.
d. When caulking is used, a letter from the coating manufacturer shall be provided identifying the recommended caulking material and the application sequence for integrating the caulking into the coating system between Coats II and III.

4. Containment Plans. Containment plans are not required for the power washing of newly installed steel or for localized power tool cleaning of damage to the newly installed steel or existing steel at connection points. When the Contractor conducts abrasive blast cleaning in the field, the containment and submittal requirements of 09 97 13.24, (Cleaning and Painting Existing Structural Steel) shall apply.
5. Worker Protection Compliance Program. A written worker protection compliance program will not be required.
6. Environmental Protection Plan of Action. A written environmental plan of action will not be required for washing of newly installed steel or for localized power tool cleaning of damage to the newly installed steel or existing steel at connection points. When the Contractor conducts abrasive blast cleaning in the field, the environmental monitoring and submittal requirements of 09 97 13.24, (Cleaning and Painting Existing Structural Steel) shall apply.
7. Waste Handling Program. Waste handling program is required for the handling of all hazardous waste. Refer to the paragraph 3.35. Submittal shall conform to 01 33 21, Contract Documents, Working Drawings, Shop Drawings, and Product Data. A written program will not be required for the handling of non-hazardous waste.

B. Work is prohibited until the Contractor receives written approval of the submittals from the Engineer. The Contractor shall not construe Engineer's approval of the submittals or materials to imply approval of any particular method or sequence for conducting the Work or for addressing health and safety concerns. Approval of the proposed plans does not relieve the Contractor from the responsibility to conduct the Work in conformance with the requirements of Federal, State, or local regulations, this Specification or to adequately protect the health and safety of all workers involved in the project and any members of the public who may be affected by the project. The Contractor shall remain solely responsible for the adequacy and completeness of the programs and work practices and adherence to them.

3.2 PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

The Contractor shall provide documentation that personnel performing quality control related functions are experienced and qualified to perform the Work and that field inspectors have completed the training as specified in the Contract Documents. The documentation shall be submitted to the Engineer and approved prior to utilizing the personnel at the Work site.

3.3 QUALITY CONTROL (QC) PLAN, INSPECTION PROCEDURES AND RECORDING SYSTEMS

A. The shop Contractor shall submit a quality control plan for providing daily job quality control of surface preparation and painting operations. The field Contractor shall submit a quality control plan conforming to SSPC-QP1. The shop and field quality control plans shall at least include the following:

1. Records of standards and specifications for coating inspection Work and their utilization.
2. System for filing inspections reports.
3. Demonstration that inspection equipment and calibration standards and procedures for calibrating the inspection equipment are available.
4. Procedures to stop nonconforming Work.
5. Procedures for verifying proper coating application.
6. Procedures to ensure that each major operation is inspected and the inspection results documented. Contractor QC inspections shall include, but are not limited to the following:

    a. Suitability of protective coverings and the means employed to control project debris, paint spatters, overspray, drips, paint spills, etc., while painting over roadways, waterways, machinery areas, and areas in the vicinity of abutments and private properties.
    b. Ambient conditions.
    c. Compressed air cleanliness.
    d. Surface preparation (solvent cleaning, pressure washing, hand/power tool or abrasive blast cleaning, etc.).
    e. Coating application (specified materials, mixing, thinning, and wet film thickness).
    f. Dry film thickness per coat.
    g. Recoat times and cleanliness between coats.
    h. Coating continuity and coverage (freedom from runs, sags, overspray, dry spray, pinholes, shadow-through, skips, misses, etc.).
    i. Copies of the Contractor's daily job quality control records shall be maintained at the shop and on site as applicable and made available for the Engineer at any time.

3.4 INSPECTION EQUIPMENT

A. The shop and field Contractor shall provide for the exclusive use of the Engineer, the following equipment for the QA observations of the Contractor''s cleaning and painting operations. All equipment shall be maintained by the Contractor in a condition that is satisfactory to the Engineer and shall remain the property of the Contractor at the conclusion of the Contract.

1. The latest editions of SSPC-Vis 1, SSPC-Vis 3, SSPC-Vis 4, or SSPC-Vis 5, as applicable to the project, or other approved visual standards.
2. SSPC Manual Volumes 1 and 2 (Latest Edition).
3. Spring Micrometer with Coarse and Extra Course Surface Profile Replica Tape.
4. Electric or Sling Psychrometer, °F.
5. U.S. Weather Bureau Psychrometric Tables.

6. Surface Thermometer, zero to one hundred fifty degrees (0° to 150°) F.
7. Probe Thermometer for Paint Temperature.
8. High/Low Thermometer for Paint Storage Area.
9. Wet Film Thickness Gauge.
10. Digital Magnetic Dry Film Coating Thickness Gauge (SSPC-PA2, Type 2).
11. Plastic Calibration Shims for Digital Magnetic Dry Film Thickness Gauge.
12. Inspector's Mirror.
13. Wind Meter.
14. Clean, White, Lint-Free, Absorbent Rags.
15. Light meter for measuring light intensity during field surface preparation/painting and inspection Work.
16. Commercially available putty knife of a minimum thickness of 40 mils and a width of one to three inches (1″ to 3″).

3.5 PAINT QUALITY ASSURANCE (QA) INSPECTOR NOTIFICATION

A. The Contractor shall notify the following pertinent agency a minimum of five (5) working days prior to beginning shop and field cleaning and painting of new steel. The agency will provide a paint inspector to assist the Engineer in performing the QA observations of the cleaning and painting portion of the Work. Failure to comply with these notifications shall be cause for not accepting the Work performed. Paint applied to steel surfaces at either location without QA acceptance may be required to be removed and reapplied at no additional cost to the City.

1. Shop. The Contractor shall notify the Engineer.
2. Field. The Contractor shall notify the Engineer.

3.6 FLOODLIGHTING

For the field Work, the Contractor shall provide floodlighting, including power sources, to supply adequate illumination to all surfaces being prepared, painted or inspected, including the underside and inside of the containment system, when containment is employed for surface preparation or coating application. The floodlighting shall be in good working condition and of a design approved by the Engineer. The floodlighting shall be adjusted to avoid glare that may blind marine and vehicular traffic. Lighting conditions shall be maintained at a minimum of thirty feet (30′ ft-candles for inspection, measured at the surface of the steel.

3.7 SHOP PRIMING OF NEW STEEL

All new structural steel shall be solvent cleaned, abrasive blast cleaned and primed in the shop with Coat I of Paint System B. Blast cleaning and painting shall take place after all shop fabrication is complete.

3.8 FIELD CLEANING AND PAINTING

A. After erection, the surfaces of the shop primed steel shall be solvent cleaned, pressure washed and hand/power tool cleaned followed by touch up with Coat I of Paint System C. Coats II and III of Paint System B shall be applied to all exposed structural steel in the completed structure.

B. When new steel is added to existing steel and the existing steel is not scheduled for repainting, the Contractor shall repair the existing coating at new steel connection points and at locations where the existing coating is damaged by the steel installation Work. The surfaces shall be solvent cleaned and hand/vacuum-shrouded power tool cleaned followed by the spot application of the penetrating sealer of Paint System H and the spot application of Coats II and III of Paint System B.

3.9 PAINTING SEQUENCE

A. Except for shop coat touch up, steel that will be exposed to view in the completed structure shall not be painted until all concrete has been placed and parapet form brackets removed. Care shall be taken by the field Contractor to protect concrete from being stained by painting operations. Painted or stained concrete surfaces shall be restored to originally intended color without damage to the concrete, as directed by the Engineer.

B. Cleaning and painting shall proceed by sections, bays or other readily identifiable parts of the Work as may be approved by the Engineer. The Work shall start at the top and proceed toward the bottom.

3.10 SURFACE PREPARATION

Surfaces shall be prepared as specified in the following paragraphs 3.11 a thru h, the pertinent SSPC Specifications and the Contract Documents. Surface conditions shall conform to the pertinent SSPC-VIS Standards. Surface preparation performed in the shop shall also conform to the following paragraph 3.11.

3.11 METHODS OF CLEANING

Methods shown in the table below apply to both shop and field cleaning and shall be performed in the order shown. The methods are invoked based on the paint system specified in the Contract Documents.

PAINT SYSTEM	SUBSTRATE	METHODS OF CLEANING
B	For abrasive blast cleaned steel.	Shop coating — (a) and (h) Shop touch up of damaged primer: Damage extending to substrate — (f) Damage not extending to substrate — (d)&/(e) Field coating of shop primed steel: (a) and (b), followed by localized repair of damage: Damage extending to the steel substrate (f) Damage not extending to the substrate — (d)&(e)
B (Coats II and III only)	For bolts and field welds	Field — (a) followed by (d)&/(e)
B (Spot prime with Coat I of System H, Spot Both Coats II and III of System B)	For existing coatings damaged due to steel repairs, new connections or Contractor's operations.	Field — (a) followed by (d)&/(e)

(Methods of Cleaning) Table Key:

Note: (a) Solvent Cleaning. Solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods approved by the Engineer shall be used in conformance with SSPC-SP 1 to remove grease, oil, diesel smoke residue, soot, and similar surface contaminates in the shop and field. Soap steam cleaning shall be used in cleaning steel open grid decks and walkways and machinery areas of drawbridges. Contaminated solvent shall be removed before it evaporates by wiping or rinsing with clean solvents to prevent a film of contaminants from remaining on the surface. Solvent wiping may be required between coats. All solvents shall be approved in writing by the paint manufacturer. (See more notes next page)

Note: (b) Low Pressure Water Cleaning (Power Washing) for Removing Contaminants between Coats. Low pressure water cleaning (LPWC) with potable water shall be performed to remove concrete spatter, dirt, debris, salt contaminants, grease, oil and similar surface interference material from shop primed structures prior to the application of additional coats in the field. LPWC shall be performed in conformance with SSPC-SP 12 except that nozzle pressures of two thousand to two thousand five hundred (2000 to 2500) psi shall be used together with a rotating tip. The pressure washer shall be equipped with easily accessible gauges and pressure regulator to ascertain and regulate the water pressure. When shop primed surfaces are to be repaired and require abrasive blasting, the cleaning shall be performed no longer than ninety-six (96) hours prior to blast cleaning. When the water is to be recycled and the coating being cleaned contains lead, it shall be tested for heavy metals (e.g. lead, arsenic, cadmium, etc.) before reuse. Water exceeding the threshold value for any heavy metal (e.g. five (5) mg/l for lead) shall not be reused.

Note: (c) High Pressure Water Cleaning (Power Washing) prior to overcoating existing coating. Cleaning method does not apply to this Specification.

Note: (d) Hand Tool Cleaning. Hand tool cleaning shall conform to SSPC-SP 2. The use of 60 grit sanding paper is recommended.

Note: (e) Power Tool Cleaning. Power tool cleaning shall conform to SSPC-SP 3. The use of 40 grit sanding discs is recommended.

Note: (f) Power Tool Cleaning to Bare Metal. Power tool cleaning to bare metal shall conform to SSPC-SP 11 with a minimum surface profile of one (1.0) mil.

Note: (g) Brush Off Blast Cleaning. Cleaning method does not apply to this Specification.

Note: (h) Near White Metal Abrasive Blast Cleaning. Expendable or recyclable abrasives shall be utilized unless otherwise approved by the Engineer. Steel shot shall not be used in the field. When steel shot is used in the shop, a sufficient amount of steel grit shall be added to the shot and the mixture maintained to produce an etched surface texture as opposed to the peened surface texture that results when blast cleaning with shot alone. The end surface condition shall conform to SSPC-SP 10, near white. Abrasives shall be dry and free of oils, grease, and other harmful materials such as lead dust, etc. at the time of use.

3.12 TEST PLATES/SECTIONS FOR SHOP PREPARATION

When abrasive blast cleaning is specified, the shop Contractor shall furnish two (2), twelve inch by twelve inch by one-quarter inch (12″ x 12″ x 1/4″) steel test plates that shall be

cleaned by the Contractor in conformance with SSPC Vis Standards and the Contract Documents. These standard test plates shall be given a clear protective coating and used as a job sample standard for cleaning operations. When approved by the Engineer as an alternative to the test plates, portions of an actual Work piece may be used in order to reach agreement on the degree of cleaning before production surface preparation begins. When the SSPC visual standards accurately depict the agreed upon degree of cleaning on the test section, the prepared section does not have to be sealed and retained for future reference. When the SSPC visual standards do not accurately depict the agreed upon degree of cleaning, the test section shall be sealed and retained or the test plates utilized. For the cleaning operations, the written requirements of this Specification, the SSPC definitions, the test plates, and the SSPC visual standards shall be used in that order for determining compliance with the Contract requirements.

3.13 FINS AND SLIVERS

All surface imperfections such as sharp fins and slivers shall be removed at no additional cost to the City.

3.14 SURFACE CONDITION PRIOR TO PAINTING

A. Residual dust, dirt and grease shall be removed from the surface as the final procedure prior to painting. This also applies between coats whenever the coating is contaminated. Cleaning includes all dust, puddles, grease, oil, exhaust from trucks, debris, concrete spatter, and other foreign matter on the surfaces being painted. Debris on surfaces adjacent to those being painted shall also be removed. Concrete spatter stains that discolor the primer need not be removed provided material is not dislodged when wiping the surface with a cloth. Cleaning shall involve vacuuming, solvent cleaning, hand/power tool cleaning and pressure washing as appropriate. Should an area of steel that had previously been cleaned become soiled, contaminated or rusted, the Contractor shall re-clean the area prior to painting. The cleaning shall be performed to the satisfaction of the Engineer at no additional cost to the City.

B. Prior to the application of paint in the shop and field, the Contractor's QC personnel shall inspect the surfaces and establish that they have been prepared in conformance with the Specifications. Upon acceptance by the Contractor's QC, the Contractor shall obtain approval from the Engineer that the surfaces to be painted during that day have been cleaned as specified.

3.15 PAINT STORAGE AND MIXING

A. Paints and thinners shall be stored in a well-ventilated area and not subject to excessive heat, open flames, electrical discharge and direct rays of the sun. The shop and field Contractors shall adhere to all manufacturers' recommendations. Materials susceptible to damage by low temperatures shall be stored in heated areas when necessary. All materials shall be used on a rotating stock basis and remain closed until used. Paints that cannot be stirred to attain normal consistency shall not be used. Paint not in actual use shall be stored in tightly covered containers at an ambient temperature not less than forty-five degrees (45°) F.

B. Containers used for storage of coating shall be maintained in a clean condition, free of foreign materials and residue.

C. Thin skins formed in the container shall be cut loose and discarded. Material that has livered, gelled, thick skinned, or become questionable shall not be used unless approved by the Engineer.

D. Paints shall be mixed in conformance with the manufacturer's instructions and as approved by the Engineer. Thinning of the paint is prohibited unless authorized by the paint manufacturer and approved by the Engineer. The Engineer shall be present whenever the paint is thinned. Materials shall not be used beyond their pot life or shelf life.

E. Waste chemical solutions, oily rags and other waste shall be removed daily. All necessary precautionary measures shall be taken to ensure that workmen and Work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of materials.

3.16 PAINT REPRESENTATIVE

The paint representative shall be a technical representative of the paint manufacturer. The paint representative shall be present during the initial execution of field Work to approve, along with the Engineer, the degree of cleanliness prior to painting and the method of application of the coating system. The Engineer may stop paint operations for failure to conform to this requirement regardless of reasons. Areas that have been cleaned prior to ceasing paint operations shall be re-cleaned if required.

3.17 SHOP PRIMING AND FIELD FINISH PAINTING

The Contractors shall conform to SSPC-PA 1 for painting application and the following paragraphs 3.18 thru 3.25.

3.18 TIME RESTRICTIONS FOR FIELD PAINTING

Field paint shall not be applied between December 15 and April 15 unless approved by the Engineer. Shop paint may be applied at any time provided it is done indoors under controlled environmental conditions.

3.19 WEATHER RESTRICTIONS FOR SHOP AND FIELD PAINTING

A. All surfaces to be painted shall be sound and cleaned in conformance with the Specifications. Paint shall not be applied when:

1. There is rain, snow, fog or mist dampening the surface.
2. The ambient air temperature in the shade is below forty degrees (40°) F.
3. The surface temperature is less than forty-five degrees (45°) F.
4. The surface temperature is expected to drop to thirty-two degrees (32°) F or below before the paint has dried.
5. The surface temperature is less than five degrees (5°) F above the dew point.
6. The relative humidity exceeds eighty-five percent (85%) except for inorganic zinc primer, which shall follow the manufacturer's written instructions.
7. The steel is hot enough to cause the paint to blister, produce a porous film, or otherwise be detrimental to the life of the paint.

B. Whenever it is suspected that moisture is condensing upon the surface, the psychrometer shall be used to check dew point, etc. If the conditions measured by the psychrometer are marginal, the Engineer may permit a well-defined area of the surface to be lightly moistened with a damp cloth and observed. If the dampness evaporates in fifteen (15) minutes, the surface shall be considered satisfactory for the application of paint. Regardless of any environmental test results, if fresh paint is damaged by the elements, the paint shall be replaced or repaired by the Contractor at no additional cost to the City.

C. The Contractor's operations shall be scheduled so that all cleaned surfaces are painted within twenty-four (24) hours. If rust bloom appears or the air or steel temperature falls below five degrees (5°) F above the dew point after cleaning and prior to application of the primer coat, the Contractor shall re-clean the affected areas to the satisfaction of the Engineer at no additional cost to the City.

3.20 SHOP PRIME APPLICATION

A. The primer coat shall be applied in the shop from agitated containers and as recommended by the manufacturer in a single application employing multiple spray passes. The dry film thickness specified in the aforementioned paragraph 2.1 A. 4. shall be applied to all surfaces to be painted except that the thickness shall be reduced to approximately one (1.0) mil within the areas of field welding and on the top and both edges of the top flange where steel stud shear developers are to be attached. Measurements shall be in conformance with SSPC-PA 2.

B. All dry spray, runs, mud cracking and damaged primer shall be removed and the area feathered prior to touch up so that the repainted surface can have a reasonably smooth appearance. Organic zinc primer shall be used to touch up the inorganic zinc primer coat in the shop and field unless otherwise approved by the manufacturer and the Engineer. All touch ups shall have the same dry film thickness as the coat being repaired. Organic zinc may be applied by brush.

3.21 INTERMEDIATE AND FINISH COAT APPLICATION

A. Prior to field coating, the surfaces of the steel shall be pressure washed with potable water in conformance with aforementioned paragraph 3.11 A. b. to remove dirt and contaminants as described in aforementioned paragraph 3.14.

B. Unless otherwise specified in the Contract Documents, Coats II and III shall be applied after all field welded areas, bolted areas and damaged primer coatings are cleaned and primed as specified or as directed by the Engineer.

C. All paint shall be applied in conformance with the manufacturer's recommendations. Spray painting will be permitted, provided the location and method of spray application are approved by the Engineer. All areas adjacent to machinery or mechanical components, etc., shall be painted by brush application unless the Engineer approves spray application. Surfaces inaccessible for painting by regular means shall be painted using sheepskin daubers or by other means as necessary to ensure coverage of the proper coating thickness.

D. The intermediate and finish coats shall be applied to the thicknesses specified in the aforementioned paragraph 2.1 A. 4. and shall be measured in conformance with

SSPC-PA 2. All edges, corners, crevices, rivets, bolts, nuts and washers shall be stripe coated. A stripe coat of the intermediate shall be applied prior to the application of the full intermediate coat. A stripe coat of the finish shall be applied prior to the application of the full finish coat. Inspection personnel shall be permitted a minimum of 10 minutes between the application of the stripe coat and the full coat to verify that it has been applied to all surfaces. Stripe coats shall be applied by brush or dauber.

E. Each coat shall be free of shadow-through, skips, misses and thin or heavy coating thickness. All defects shall be repaired prior to the application of the next coat at no additional cost to the City. The steel shall be kept dust free during painting operations and care shall be taken to protect newly coated surfaces from cleaning operations. When an area that had previously been cleaned or painted becomes soiled, contaminated or rusted, the area shall be re-cleaned to the specified condition and completely recoated at no additional cost to the City.

F. The finish coat shall be applied within thirty (30) days after the intermediate coat unless approved in writing by the paint manufacturer. If the recoat window is exceeded, the surface shall be re-cleaned as approved by the paint manufacturer and the Engineer.

3.22 BOLTS AND FIELD WELDS

Bolts for field assembly shall not be shop coated. After field welding and prior to applying Coat II (first field coat), these bolts and field weld areas shall be cleaned. Cleaning shall be accomplished by solvent cleaning followed by hand/power tool cleaning as specified in the aforementioned paragraph 3.11 A. a. and d. or e., respectively. The first field coat (Coat II) shall be applied within twenty-four (24) hours of cleaning. Primer paint stained from rusted bolts shall be solvent cleaned in conformance with SSPC-SP 1 before Coat II is applied.

3.23 CONTROL OF OVERSPRAY AND SPILLS

A. The Contractor shall protect the environment from paint droplets, overspray and spills by providing containment for the paint application area and be fully responsible for any damage resulting from wind or the cleaning and painting operations. Whenever the method of protection fails to function at the required level of efficiency during the execution of the Work, the Contractor shall immediately suspend all operations except those associated with minimizing adverse impact to the environment. Operations shall not resume until modifications have been made to correct the cause of the failure. Containment screens, curtains, and tarpaulins shall be fire retardant.

B. Paint operations may be stopped by the Engineer due to wind if the wind velocity exceeds twenty (20) mph unless specific precautions are taken (e.g., specially designed containment system) to prevent the escape of paint droplets and overspray. The proposed methods must be approved by the Engineer.

3.24 CAULKING

A. The Contractor shall caulk the following areas with a material approved by the paint manufacturer. Caulking shall be installed between the intermediate and finish coats at no additional cost to the City:

1. Gaps between steel members that are one-eighth inch (1/8″) or greater that cannot be cleaned and sealed during the application of the coatings.
2. Interface between the steel and concrete surfaces where through-girders penetrate the concrete. Caulking shall be applied to the above deck surfaces only. Below deck surfaces at the through-girder/concrete interface shall not be caulked.

3.25 DEFECTIVE WORK

The Contractor shall be responsible for the satisfactory application of paint and neither conditions during application nor Laboratory acceptance of paint shall relieve the Contractor of responsibility of obtaining a satisfactory paint system. Painting shall be done in a neat and workmanlike manner. When rusting occurs or a paint coat lifts, blisters, wrinkles or shows evidence of having been applied under unfavorable conditions; the workmanship is poor; impure or unauthorized paint has been used; or for any other reason the painting is unsatisfactory; the affected paint shall be removed and the steel thoroughly cleaned and repainted at no additional cost to the City. These areas shall provide a uniform appearance throughout the structure.

3.26 REPAIR OF COATINGS

A. Repair of Damaged Coatings due to Contractor Operations. Newly installed coatings that are damaged as a result of the Contractor's operations shall be repaired using the same materials at no additional cost to the City.

B. Repair of New Connections and Existing Coatings Damaged During Steel/Deck Repairs. When the existing structure is not scheduled for repainting, the repair of existing coatings damaged due to steel repairs or the installation of new connections on existing steel shall involve solvent cleaning and spot hand or vacuum-shrouded power tool cleaning of the existing coating. Preparation shall be in conformance with aforementioned paragraph 3.11 A. a. and d. or e. followed by the application of spot coats of Coat I of Paint System H and Coats II and III of Paint System B.

3.27 FINAL IDENTIFICATION

When the final coat of paint is dry, the Contractor shall stencil on the structure a legend indicating the type of paint used in each coat, and the month and year in which each application was completed. The letters of the stencil shall be two to two and one-half inches (2″ to 2-1/2″) high and shall be applied with black paint inside a fascia stringer near the abutment at a location selected by the Engineer. When more than one (1) paint system is used, additional stencils shall be applied.

3.28 FIELD CLEANING WASTE CONTAINMENT

The requirement for containment, if any, is dependent upon the method of cleaning used as specified in the following paragraph 3.30. The requirement for a written containment system plan is also dependent upon the method of cleaning as specified in paragraph 3.30.

3.29 FIELD CLEANING CONTAINMENT SYSTEM PLAN GUIDELINES

A When the newly installed steel will be abrasive blast cleaned, the containment requirements and submittals specified in 09 97 13.24 (Cleaning and Painting Existing Structural Steel) shall apply. Containment plans are not required for the pressure washing of newly installed steel, for the localized power tool cleaning of damage to the newly installed steel or for the touch up of existing steel at damaged areas and connection points. Even though a written Containment System Plan is not required, the Contractor shall comply with the technical requirements below when containment materials are used as specified in the following paragraph 3.30.

1. The containment system or equipment shall not encroach upon the minimum structure clearances shown within the Contract Documents, unless otherwise approved by the Engineer.
2. All curtains, screens or tarpaulins used for containment shall be secured. Connections to the steel Work of the structure shall be made with clamps or other devices approved by the Engineer. Drilling holes anywhere into the existing structure or welding to the existing steel Work will not be permitted. Attachments or fasteners to the structure shall not be permanent. No load shall be attached to the structure railings unless details and calculations showing loading have been approved by the Engineer.
3. Containment curtains, screens and tarpaulins shall be fire retardant.

3.30 CONTAINMENT SYSTEM REQUIREMENTS BY METHOD OF PREPARATION

A. Washing. When power washing newly installed steel coated only with inorganic zinc primer, the surfaces may be washed without any containment or collection of the water.

B. Power Tool Cleaning. Containment is not required for localized power tool cleaning of the inorganic zinc primer.

1. When the existing structure is not scheduled for repainting, but the existing coating requires repairs at connection points or at areas damaged by the new steel installation, a SSPC Class 3P containment shall be required. Collected paint chips and debris shall be disposed of in conformance with applicable regulations and paragraphs 3.35 through 3.37.
2. The use of vacuum-shrouded power tools for preparing the existing coatings may eliminate the need for the specified containments if it can be demonstrated that paint chips and debris are satisfactorily collected by the vacuum shrouding and that any uncollected detached paint chips are cleaned up from the ground at the end of the shift. In no case shall paint chips be permitted to fall into streams, wetlands, wetland buffers or other bodies of water.

C. The Contractor shall satisfy ambient air and worker exposure requirements established by the Maryland Department of the Environment and MOSH.

D. Containment systems shall be maintained while Work is in progress. Public access to all rigging, scaffolding, containment systems and Work sites shall be denied at all times.

3.31 WORKER PROTECTION

In addition to complying with all applicable OSHA and MOSH regulations, the Contractor shall provide a hand wash station with soap and towels at each Work site. The hand wash and shower facilities shall be available for the Contractor's and the City's personnel. Hygiene facilities shall conform to the requirements specified in federal requirements. A written worker protection compliance program is not required.

3.32 ENVIRONMENTAL PROTECTION

At the end of each working day and upon completion of all project activities, surrounding property, concrete, pavement, slope protection, soil, water, etc., shall be cleaned free of visible project debris resultant from cleaning and painting activities.

3.33 ENVIRONMENTAL PROTECTION PLAN OF ACTION

A written environmental protection plan of action is not required unless the coatings will be abrasive blast cleaned. When the coatings are blast cleaned, a Plan of Action conforming to Section 09 97 13.24, (Cleaning and Painting Existing Structural Steel) shall be provided.

3.34 FIELD CLEANING WASTE DISPOSAL

All project waste that is collected under this Specification shall be handled, stored, transported and disposed of in conformance with Federal, State, and local regulations.

3.35 WASTE HANDLING PROGRAM

A. A Waste Handling Program is required for the handling, storage and disposal of all hazardous waste. All submittals shall be provided to the Engineer. Work is prohibited until the submittals are approved by the Engineer. Ten (10) copies of the waste handling plan shall be provided in writing on company letterhead.

B. The Plan of Action shall address the following:

1. Names, addresses and licenses for the proposed hazardous waste transporters and disposal facilities.
2. Hazardous waste handling and storage procedures.
3. Waste sampling and analysis procedures.
4. All test results shall be provided to the Engineer within five (5) days of sample collection.

3.36 HAZARDOUS WASTE HANDLING AND DISPOSAL

When the existing coating is removed at connection points with the new steel or at areas of damage, the collected paint chips shall be tested by Toxicity Characteristic Leaching Procedure (TCLP) as outlined in COMAR 26.13.02 and the EPA Test Procedure Manual to determine if the waste is hazardous. When the waste is hazardous, it shall be stored, manifested, transported and disposed of in conformance with Federal regulations and COMAR 26.13.03.

3.37 NONHAZARDOUS WASTE HANDLING AND DISPOSAL

All non-hazardous waste shall be disposed of in conformance with Federal, State, county and local regulations.

PART 4 MEASUREMENT AND PAYMENT

A. The Contract Unit Price for the item specified in the Contract Documents will be full compensation for all permits, Working Drawings, daily quality control records and professional engineer's services used for containment when required. Also, sampling and testing materials for heavy metal content including any revisions and resubmissions of the submittals that may be required during the execution of the Work and all other incidentals necessary to complete all cleaning and painting operations including providing safe access for inspections, flood lighting, test plates, drums, collection and storage at the temporary storage site, hauling and disposal at an approved industrial waste site or hazardous waste site, removal of debris and all material, labor, equipment (including test equipment), tools and incidentals necessary to complete the Work.

B. Cleaning and painting new structural steel will not be measured but the cost will be incidental to the pertinent Fabricated Structural Steel item.

C. Cleaning and painting existing structural steel will not be measured but will be paid for at the Contract lump sum price for the pertinent cleaning and painting item.

D. All costs associated with repair of existing coatings due to new connections and existing coatings damaged during steel/deck repairs will not be measured but will be incidental to the pertinent Repair, Structural Steel or Cleaning and Painting items included in the Contract Documents.

09 97 13.24 EXTERIOR STEEL COATINGS (CLEANING AND PAINTING EXISTING STRUCTURAL STEEL)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of cleaning and painting existing structural steel in the field. The Work includes partial cleaning and painting (zone painting or overcoating), complete cleaning and painting (total paint removal and replacement), and repairing existing coatings damaged during repairs or by the Contractor's operations on or adjacent to the bridge. The Work to be performed shall be as specified in the Contract Documents, these Specifications, and as directed by the Engineer. Refer to 09 97 13.23, (Cleaning and Painting New Structural Steel) for cleaning and painting new structural steel.

1.2 AREAS TO BE CLEANED AND PAINTED

A. Portions of the existing structure and the appropriate cleaning and painting requirements shall be as specified in the Contract Documents based on the following definitions:

1. Zone Painting. When zone painting is specified, all bearings and beam ends at the abutment and pier locations specified in the Contract Documents and all outside facing surfaces on specified stringers shall be cleaned and painted. The cleaning shall conform to the following paragraph 3.10 as dictated by the Paint System specified in the following paragraph 2.1.

   a. Outside facing surfaces are those surfaces that face away from the structure. These surfaces include the underside of the top flange and the web facing away from the structure, the top of the bottom flange, the outside edge of the bottom flange, the underside of the bottom flange, the inside edge of the bottom flange and a portion of the top of the bottom flange on the inside facing surface. The transition between the existing and new coating on the top of the bottom flange shall occur approximately half way between the outside edge of the flange and the fillet. A sharp well defined transition between the new and existing coating will not be required, but the existing coating shall be feathered. All attached bearing assemblies are included in the cleaning and painting.
   b. Areas defined as bearings and beam ends shall include all structural steel and bearing assemblies for a distance of five feet (5′) from the ends of the stringers at the abutments and five feet (5′) in each direction from the center line of the piers for a total distance of ten feet (10′).

2. Overcoating. When overcoating is specified, the entire steel surface area shall be cleaned and painted in conformance with the Paint System specified in the Contract Documents.
3. Total Removal and Replacement. When total removal and replacement of the coating is specified, the coating shall be completely removed by abrasive blast cleaning followed by the application of the Paint System specified in 2.1.

1.3 GENERAL

A. The Work shall conform to SSPC Standards and the manufacturer's recommendations unless otherwise approved by the Engineer.

B. Any structural defects including cracks, missing bolts or rivets, deterioration, etc., detected during cleaning and painting shall be brought to the attention of the Engineer. The Contractor shall protect utility pipes, conductors, light fixtures and conduits from these operations; they shall not be cleaned and painted unless specified in the Contract Documents.

C. The Contractor shall perform Quality Control (QC) inspections to ensure that each phase of the Work complies with Specification requirements.

D. All maintenance of traffic required for corrective action shall be at no additional cost to the City. When a railroad is included in the project, all railroad fees shall be as specified in the Contract Documents, except any additional impact on the railroad and associated fees due to corrective actions or additional inspections shall be at no additional cost to the City.

E. The Contractor shall conform to the requirements of OSHA, regarding lead, arsenic, cadmium, etc., exposure in construction standards; and the applicable Federal and State

laws, including COMAR 26.16.01(Accreditation and Training for Lead Paint Abatement Services).

F. Existing paint systems or abrasives used for blast cleaning may include toxic metals such as lead, arsenic, cadmium, chromium, etc., which may be considered hazardous waste when removed and tested as specified in the Toxicity Characteristic Leaching Procedure (TCLP), EPA Method 1311.

G. Prior to bidding, the Contractor shall be familiar with the current environmental regulations and safety procedures. The City and the Contractor are considered "Co-Generators" of all waste associated with the Work. The Contractor shall be responsible for preventing waste from entering into the environment by containing, collecting, storing, testing and disposing of all waste in conformance with Federal, State and local regulations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Paint systems shall be as specified in the Paint Systems Table in 09 97 13.23, paragraph 2.1 A. 4 (Cleaning and Painting New Structural Steel).

B. Paint Systems. All paint within the paint systems for each bridge specified herein shall be from the same manufacturer. When more than one (1) paint system is used on a bridge, all paint shall be from the same manufacturer. The color of the finish coat for zone painting, overcoating and total removal and replacement shall be as specified in the Contract Documents. The color of the touch up finish coat on existing steel shall match the existing finish coat.

CLEANING AND PAINTING	PAINT SYSTEM
Zone Painting	F
	C
Overcoating	F
	H
Total Removal and Replacement	C
Existing Coatings Damaged During Construction	F — Spot Coat I and spot Coat III Only

When more than one (1) system is specified, the Paint System will be specified in Contract Documents.

C. Abrasives. Abrasive media used in blast cleaning operations shall result in blasted surfaces having a surface profile height of one and one-half to four (1.5 to 4.0) mils as determined by a spring micrometer with surface profile replica tape. The Contractor shall provide material safety data sheets (MSDS) for the abrasives used and a letter from the abrasive supplier indicating that the expendable abrasives conform to SSPC-AB 1 and the recyclable abrasives conform to SSPC-AB 3. The cleanliness of recycled abrasives shall be verified in conformance with SSPC-AB 2.

PART 3 EXECUTION

3.1 SUBMITTALS

A. The Contractor shall submit the following drawings, plans and information for accomplishing the Work to the Engineer for approval. Work is prohibited until the submittals are approved by the Engineer.

1. Quality Control (QC) Plan. A written QC program is required. Refer to the following paragraph 3.3. Submittals shall conform to 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).
2. Paint Manufacturer Certifications and Letters. The following information shall be submitted in conformance with 09 97 13.23, (Cleaning and Painting New Structural Steel), paragraph 3.1 A. 2. d. including subparagraphs to the City.

    a. When detergents or additives are proposed to be incorporated into the water used for washing, the Contractor shall provide MSDS and a letter from the coating manufacturer that approves the use of the detergents with their coating.
    b. The manufacturer shall provide a letter that approves any proposed solvents for use in solvent cleaning prior to painting or between coats. MSDS for the solvents shall be provided.
    c. The paint manufacturer's application and thinning instructions, MSDS and product data sheets shall be provided.
    d. When caulking is used, a letter from the coating manufacturer shall be provided identifying the recommended caulking material and the application sequence for integrating the caulking into the coating system between Coats II and III.

3. Containment Plans. Written Containment Plans are required. Refer to the following paragraph 3.29. Submittals shall conform to 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).
4. Worker Protection Compliance Program. A written Worker Protection Program is required when lead paint is being disturbed. Refer to the following paragraph 3.32. Submittals shall conform to 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).
5. Environmental Protection Plan of Action. A written Environmental Protection Plan of Action is required. Refer to the following paragraph 3.34. Submittal shall conform to 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).
6. Waste Handling Program. Waste Handling Program is required for the handling of all hazardous waste regardless of the presence of lead. Submittals shall conform to 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data). A written program will not be required for the handling of nonhazardous waste.

B. Work is prohibited until the Contractor receives written approval of the submittals from the Engineer. The Contractor shall not construe Engineer approval of the submittals to imply approval of any particular method or sequence for conducting the Work or for addressing health and safety concerns. Approval of the proposed plans does not relieve the Contractor from the responsibility to conduct the Work in conformance with Federal, State,

or local regulations, this Specification or to adequately protect the health and safety of all workers involved in the project and any members of the public who may be affected by the project. The Contractor shall remain responsible for the adequacy and completeness of the programs and work practices and adherence to them.

3.2 PERSONNEL AND RESPONSIBILITIES

1. The Contractor shall provide documentation that all applicable project personnel conform to the training and accreditation requirements of COMAR 26.16.01, (Accreditation and Training for Lead Paint Abatement Services).

B. The documentation shall be submitted to the Engineer and approved prior to utilizing the personnel at the Work site.

1. QC Inspectors. Provide documentation that personnel performing quality control related functions are experienced and qualified to perform the Work and have completed the training specified for SSPC-QP1 and when lead paint is being disturbed, SSPC-QP2.
2. Competent Person. A competent person as specified in SSPC-QP2 shall be onsite full time when lead paint is being disturbed. The competent person shall perform all quality control related functions involving the oversight of worker and environmental protection, containment performance and waste handling on lead paint removal projects. The Contractor shall provide documentation of the competent person's qualifications, including experience and records of training as specified in SSPC-QP2. The competent person shall hold a current SSPC C3 Competent Person Certificate or current C5 refresher, a certificate of completion of Lead in Construction Training and shall be accredited in conformance with COMAR 26.16.01, (Accreditation and Training for Lead Paint Abatement Services).
3. Certified Industrial Hygienist (CIH). The Contractor shall provide the services of a CIH when the Work involves the disturbance or removal of lead paints. The Contractor shall provide evidence that the CIH has the following qualifications and insurance requirements:

    a. Certification by the American Board of Industrial Hygiene.
    b. Field sampling and oversight experience involving lead paint removal on bridges.
    c. $1,000,000.00 errors and omissions insurance coverage for this type of Work.

C. All field sampling and testing shall be performed by the CIH or by an employee working under the direct supervision of the CIH and shall be witnessed by a representative of the City. The Contractor shall notify the Engineer a minimum of twenty-four (24) hours prior to sampling and testing.

D. The CIH shall review all results of sampling and testing performed on the project. The CIH or a person working under the direction of the CIH shall prepare written reports interpreting these results for compliance to the applicable regulations. The Contractor shall submit a copy of all reports, analysis, etc., to the Engineer. All copies shall be submitted within five (5) working days after sampling unless otherwise approved by the Engineer.

E. A written certification shall be submitted within five (5) days after the end of each month stating that the Contractor has complied with the plans of action and compliance programs specified within this Specification for worker protection, environmental protection, and waste handling and has addressed any deficiencies found. The certification shall be prepared by the CIH or a person working under the direction of the CIH.

3.3 QUALITY CONTROL (QC) PLAN, INSPECTION PROCEDURES AND RECORDING SYSTEMS

A. The Contractor shall submit a Quality Control Plan for providing daily job quality control in conformance with SSPC-QP1 for surface preparation and painting operations. Work is prohibited until the submittals are approved by the Engineer. The Quality Control Plan shall at least include the following:

1. Records of standards and specifications for coating inspection Work and their utilization.
2. System for filing inspections reports.
3. Demonstration that inspection equipment and calibration standards and procedures for calibrating the inspection equipment are available.
4. Procedures to stop nonconforming Work.
5. Procedures for verifying proper coating application.
6. Procedures to ensure that each major operation is inspected and the inspection results documented. Contractor QC inspections shall at least include:

    a. Effectiveness of protective coverings to control project debris, paint spatters, overspray, drips, paint spills, etc., while painting over roadways, waterways, machinery areas and areas in the vicinity of abutments and private properties.
    b. Ambient conditions.
    c. Compressed air cleanliness.
    d. Surface preparation (solvent cleaning, pressure washing, hand/power tool or abrasive blast cleaning, etc.).
    e. Coating application (specified materials, mixing, thinning and wet film thickness).
    f. Dry film thickness per coat.
    g. Recoat times and cleanliness between coats.
    h. Coating continuity and coverage (freedom from runs, sags, overspray, dry spray, pinholes, shadow-through, skips, misses, etc.).

B. Copies of the Contractor's daily job quality control records shall be maintained on site and made available for the Engineer at any time.

3.4 INSPECTION EQUIPMENT

A. The Contractor shall provide for the exclusive use of the Engineer, the following equipment for the QA observations of the Contractor's cleaning and painting operations. All equipment shall be maintained by the Contractor in a condition that is satisfactory to the Engineer and shall remain the property of the Contractor at the conclusion of the Contract.

1. The latest editions of SSPC-Vis 1, SSPC-Vis 3, SSPC-Vis 4, or SSPC-Vis 5, as applicable to the project or other approved visual standards.

2. SSPC Manual volumes 1 and 2 (latest edition).
3. Spring micrometer with coarse and extra course surface profile replica tape.
4. Electric or sling psychrometer, °F.
5. U.S. Weather Bureau Psychrometric Tables.
6. Surface thermometer, zero to one hundred fifty degrees (0° to 150°) F.
7. Probe thermometer for paint temperature.
8. High/low thermometer for paints storage area.
9. Wet film thickness gauge.

B. Digital magnetic dry film coating thickness gauge (SSPC-PA 2, Type 2).

C. Plastic calibration shims for digital magnetic dry film thickness gauge.

D. Inspector's mirror.

E. Wind meter.

F. Clean, white, lint free, absorbent rags.

G. Light meter for measuring light intensity during surface preparation/painting and inspection Work.

H. Commercially available putty knife of a minimum thickness of forty (40) mil and a width of one to three inches (1″ to 3″).

3.5 PAINT QUALITY ASSURANCE (QA) INSPECTOR NOTIFICATION

The Contractor shall notify the Engineer a minimum of five (5) working days prior to beginning field cleaning and painting of new and existing steel. The Engineer will provide a paint inspector to assist the Engineer in performing the QA observations of the cleaning and painting portion of the Work. Failure to comply with this notification shall be cause for not accepting the Work performed. Paint applied to steel surfaces without QA acceptance may be required to be removed and reapplied at no additional cost to the City.

3.6 FLOODLIGHTING

The Contractor shall provide floodlighting, including power sources, to supply adequate illumination to all surfaces being prepared, painted or inspected, including the underside and inside of the containment system, when containment is employed for surface preparation or coating application. The floodlighting shall be in good working condition and of a design approved by the Engineer. The floodlighting shall be adjusted to avoid glare that may blind marine and vehicular traffic. Lighting conditions shall be maintained at a minimum of 30 ft-candles for inspection, measured at the surface of the steel.

3.7 FIELD CLEANING AND PAINTING

Portions of the existing structure and the appropriate cleaning and painting requirements shall be as specified in the Contract Documents.

3.8 PAINTING SEQUENCE

A. Steel that will be exposed to view in the completed structure shall not be painted until all concrete has been placed and parapet form brackets removed. The Contractor shall protect concrete from being stained by painting operations. Painted or stained concrete surfaces shall be restored to originally intended color without damage to the concrete, as directed by the Engineer.

B. Cleaning and painting shall proceed by sections, bays or other readily identifiable parts of the Work as may be approved by the Engineer. The Work shall start at the top and proceed toward the bottom.

3.9 SURFACE PREPARATION

Surfaces shall be prepared as specified in the pertinent SSPC Specifications and the Contract Documents. Surface conditions shall conform to the pertinent SSPC-VIS Standards and the test plates/sections specified in the following paragraph 3.11.

3.10 METHODS OF CLEANING

A. Methods shown in the following table apply to both shop and field cleaning and shall be performed in the order shown. The methods are invoked based on the Paint System specified in the Contract Documents:

PAINT SYSTEM	SUBSTRATE	METHOD OF CLEANING
C, D & E	Abrasive blast cleaned steel	Existing Paint to be Removed — Localized (1) and (2) and complete (8)
E, F & H	Overcoating existing paint	Existing Paint to be Overcoated — Localized (1) and complete (3) followed by (4)&/(5)

1. Cleaning solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods approved by the Engineer shall be used in conformance with SSPC-SP 1 to remove grease, oil, diesel smoke residue, soot and similar surface contaminates. Soap steam cleaning shall be used in cleaning steel open grid decks and walkways and machinery areas of drawbridges. Contaminated solvent shall be removed before it evaporates by wiping or rinsing with clean solvents to prevent a film of contaminants from remaining on the surface. Solvent wiping may be required between coats. All solvents shall be approved in writing by the paint manufacturer.
2. Low Pressure Water Cleaning (Power Washing) Prior to Blast Cleaning or for Removing Contaminants between Coats. Low pressure water cleaning (LPWC) with potable water shall be performed on all bearings, transverse and longitudinal joints and beam ends prior to abrasive blast cleaning to remove salts, pigeon droppings, dirt and debris. LPWC shall also be performed as necessary between coats to remove surface contamination.
3. LPWC shall be performed in conformance with SSPC-SP 12 except that nozzle pressures of 2000 to 2500 psi shall be used together with a rotating tip. The pressure washer shall be equipped with easily accessible gauges and pressure regulator to ascertain and regulate the water pressure. The cleaning shall be performed no longer than ninety-six (96) hours prior to blast cleaning. This method

shall also be used to remove concrete spatter, dirt, debris, salt contaminants, grease, oil and similar surface interference material from newly coated structures prior to the application of additional coats.

4. When the water is to be recycled and the coating being cleaned contains lead, it shall be tested for heavy metals (e.g. lead, arsenic, cadmium, etc.) before reuse. Water exceeding the threshold value for any heavy metal (e.g. five (5) mg/l for lead) shall not be reused.
5. High Pressure Water Cleaning (Power Washing) Prior to Overcoating Existing Coating. High pressure water cleaning (HPWC) with potable water shall be performed on existing structures prior to hand and power tool cleaning in preparation for overcoating to remove loose paint, loose rust, loose mill scale, salts, bird droppings, dirt, debris, grease, oil, hydrocarbons, diesel smoke residue, soot, chalk, and similar surface interference material. HPWC shall be performed in conformance with SSPC-SP 12, WJ-4, except that nozzle pressures of 4000 to 6000 psi shall be used together with a rotating tip. A biodegradable detergent may be added to the water for the removal of grease, oil, and hydrocarbons if approved by the Engineer. The pressure washer shall be equipped with easily accessible gauges and pressure regulator to ascertain and regulate the water pressure. The cleaning shall be performed at close range to the surface, approximately six inch (6″), using a pattern of overlapping drops followed by cross-hatching with the same overlap. At the end of cleaning, the swirling patterns created by the rotating tip shall not be visible on the surface.
6. When the water is to be recycled, and the coating being cleaned contains lead, it shall be tested for heavy metals (e.g. lead, arsenic, cadmium, etc.) before reuse. Water exceeding the threshold value for any heavy metal (e.g. five (5) mg/l for lead) shall not be reused.
7. Hand Tool Cleaning. Hand tool cleaning shall conform to SSPC-SP 2. The use of 60 grit sanding paper is recommended.
8. Power Tool Cleaning. Power tool cleaning shall conform to SSPC-SP 3. The use of 40 grit-sanding discs is recommended.
9. Power Tool Cleaning to Bare Metal. Power tool cleaning to bare metal shall conform to SSPC-SP 11 with a minimum surface profile of one (1.0) mil.
10. Brush Off Blast Cleaning. Expendable abrasives or steel grit propelled through nozzles or steel grit propelled by centrifugal wheels shall be utilized unless otherwise directed by the Engineer. The end surface condition shall conform to SSPC-SP 7, Brush Off Blast Cleaning. Abrasives shall be dry and free of oils, grease, and other harmful materials such as lead dust, etc., at the time of use.
11. Near White Metal Abrasive Blast Cleaning. Expendable or recyclable abrasives shall be utilized unless otherwise approved by the Engineer. Steel shot shall not be used in the field. When steel shot is used in the shop, a sufficient amount of steel grit shall be added to the shot and the mixture maintained to produce an etched surface texture as opposed to the peened surface texture that results when blast cleaning with shot alone. The end surface condition shall conform to SSPC-SP 10, near white. Abrasives shall be dry and free of oils, grease, and other harmful materials such as lead dust, etc. at the time of use.

3.11 TEST PLATES/SECTIONS

When abrasive blast cleaning is specified, the Contractor shall furnish two (2), twelve inch by twelve inch by one-quarter inch (12″ x 12″ x 1/4″) steel test plates that shall be cleaned by the Contractor in conformance with SSPC Vis Standards and the Contract Documents.

These standard test plates shall be given a clear protective coating and used as a job sample standard for cleaning operations. When approved by the Engineer as an alternative to the test plates, portions of an actual Work piece may be used in order to reach agreement on the degree of cleaning before production surface preparation begins. When the SSPC visual standards accurately depict the agreed upon degree of cleaning on the test section, the prepared section does not have to be sealed and retained for future reference. When the SSPC visual standards do not accurately depict the degree of cleaning, the test section shall be sealed and retained or the test plates utilized. For the production cleaning operations, the written requirements of this Specification, the SSPC definitions, the test plates and the SSPC visual standards shall be used in that order for determining compliance with the contractual requirements.

3.12 REMOVAL OF VEGETATION, PLANKING AND SIGNAGE

A. Vegetation overhanging or fouling the structure shall be removed prior to surface preparation.

B. When the structure to be painted has planking (timber or plywood) between the stringers, it shall be carefully removed in the areas of Work operations. The Contractor shall be responsible for storing and maintaining the planking in good condition and disposing of all debris on the planking. Unless otherwise directed by the Engineer, the planking will not have to be reinstalled until cleaning and painting operations are complete. The Engineer may direct the Contractor to reinstall portions of the planking prior to opening any restricted lane to traffic during the same working day. The Engineer may also direct the Contractor to reinstall planking during periods of Work stoppage.

C. When the fascia webs of the structure contain street signs identifying the name of the street crossing the structure, they shall be permanently removed during the cleaning operations. These signs shall be removed before cleaning operations begin in the area. Areas exposed as a result of the sign removal including bolt holes, etc., shall be cleaned and painted. The Contractor shall notify the Engineer who will notify the appropriate traffic personnel whenever the sign is removed. Street signs may be reinstalled by utilizing the Contractor's maintenance of traffic. The Engineer will coordinate this Work with the Contractor.

3.13 RUST SCALE, PACK RUST, FINS AND SLIVERS

Regardless of the method of cleaning, surface imperfections such as sharp fins and slivers, rust scale and pack rust shall be removed by a combination of cleaning procedures such as using hand or power impact tools (using chipping hammers or scaling hammers), blast cleaning, etc., without scarring good steel.

3.14 FEATHERING AND REMOVAL OF DEFECTS IN EXISTING COATING

For projects involving the touch up or overcoating of newly installed steel or existing coatings in the field, regardless of the method used for cleaning, the Contractor shall feather the edges of old paint permitted to remain so that the repainted surface can have a reasonably smooth appearance. Portions of paint on previously painted surfaces that are chalky, powdered, cracked, or otherwise unacceptable shall be removed. Runs and sags in the existing paint on the outside facing surfaces of fascia beams over highways shall be removed to provide a smooth streamline appearance after the application of the new coating.

3.15 SURFACE CONDITION PRIOR TO PAINTING

A. Residual dust, dirt and grease shall be removed as the final procedure prior to painting. This applies to existing coatings that have been prepared for overcoating, surfaces that have been cleaned to bare metal and between coats whenever the coating is contaminated. Cleaning includes all dust, puddles, grease, oil, exhaust from trucks, debris and other foreign matter on the surfaces being painted. Debris on surfaces adjacent to those being painted shall also be removed. Cleaning shall involve vacuuming, solvent cleaning and pressure washing as appropriate. Should an area of steel that had previously been cleaned become soiled, contaminated or rusted, the Contractor shall reclean the area prior to painting. The cleaning shall be performed to the satisfaction of the Engineer at no additional cost to the City.

B. Prior to the application of paint, the Contractor's QC personnel shall inspect the surfaces and establish that they have been prepared in conformance with the Specifications.

C. Upon acceptance by the Contractor's QC, the Contractor shall obtain approval from the Engineer that the surfaces to be painted during that day have been cleaned as specified.

3.16 PAINT STORAGE AND MIXING

A. Paints and thinners shall be stored in well-ventilated areas and not subject to excessive heat, open flames, electrical discharge and direct rays of the sun. The Contractor shall adhere to all manufacturers' recommendations. Materials susceptible to damage by low temperatures shall be stored in heated areas when necessary. All materials shall be used on a rotating stock basis and remain closed until used. Paints that cannot be stirred to attain normal consistency shall not be used. Paint not in actual use shall be stored in tightly covered containers at an ambient temperature not less than forty-five degrees (45°) F. Containers used for storage of coating shall be maintained in a clean condition, free of foreign materials and residue.

B. Thin skins formed in the container shall be cut loose and discarded. Material that has livered, gelled, thick skinned or become questionable shall not be used unless approved by the Engineer.

C. Paints shall be mixed in conformance with the manufacturer's instructions and as approved by the Engineer. Thinning of the paint is prohibited unless authorized by the paint manufacturer and approved by the Engineer. The Engineer shall be present whenever the paint is thinned. Materials shall not be used beyond their pot life or shelf life.

D. Waste chemical solutions, oily rags and other waste shall be removed daily. All necessary precautionary measures shall be taken to ensure that workmen and Work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of materials.

3.17 PAINT REPRESENTATIVE

The paint representative shall be a technical representative of the paint manufacturer. The paint representative shall be present during the initial execution of the Work to approve with the Engineer the degree of cleanliness prior to painting and the method of application of the coating system. The Engineer may stop paint operations for failure to

conform to this requirement regardless of reasons. Areas that have been cleaned prior to ceasing paint operations shall be recleaned if required.

3.18 FIELD PAINTING

The Contractor shall conform to SSPC-PA 1 for painting application and the following paragraphs 3.19 thru 3.22.

3.19 TIME RESTRICTIONS FOR FIELD PAINTING

Field paint shall not be applied between December 15 and April 15 unless approved by the Engineer.

3.20 WEATHER RESTRICTIONS FOR FIELD PAINTING

A. All surfaces to be painted shall be sound and cleaned in conformance with the Specification. Exceptions to temperature and humidity requirements specified herein may be permitted for paint conforming to Paint Systems F and G when approved in writing by the paint manufacturer and approved by the Engineer. However, paint shall not be applied when the surface temperature is less than thirty-five degrees (35°) F.

B. Paint shall not be applied when:

1. There is rain, snow, fog, or mist dampening the surface.
2. The ambient air temperature in the shade is below forty degrees (40°) F.
3. The surface temperature is less than forty-five degrees (45°) F.
4. The surface temperature is expected to drop to thirty-two degrees (32°) F or below before the paint has dried.
5. The surface temperature is less than five degrees (5°) F above the dew point.
6. The relative humidity exceeds eighty-five percent (85%).
7. The steel is hot enough to cause the paint to blister, produce a porous film or otherwise be detrimental to the life of the paint.

C. Whenever it is suspected that moisture is condensing upon the surface, the psychrometer shall be used to check dew point, etc. If the conditions measured by the psychrometer are marginal, the Engineer may permit a well-defined area of the surface to be lightly moistened with a damp cloth and observed. If the dampness evaporates in fifteen (15) minutes, the surface shall be considered satisfactory for the application of paint. Regardless of any environmental test results, when fresh paint is damaged by the elements, the paint shall be replaced or repaired by the Contractor at no additional cost to the City.

D. The Contractor's operations shall be scheduled so that all cleaned surfaces are painted within twenty-four (24) hours. If rust bloom appears or the air or steel temperature falls below five degrees (5°) F above the dew point after cleaning and prior to application of the primer coat, the Contractor shall reclean the affected areas to the satisfaction of the Engineer at no additional cost to the City.

3.21 APPLICATION OF PRIME, INTERMEDIATE AND FINISH COATS

A. All surfaces shall comply with the specified degree of preparation prior to the application of the paint system.

B. All paint shall be applied in conformance with the manufacturer"s recommendations. Spray painting will be permitted provided the location and method of spray application are approved by the Engineer. All areas adjacent to machinery or mechanical components, etc., shall be painted by brush application unless the Engineer approves spray application. Surfaces inaccessible for painting by regular means shall be painted using sheepskin daubers or by other means as necessary to ensure coverage of the proper coating thickness.

C. All coats shall be applied to the thicknesses specified in the Paint Systems Table included in the 09 97 13.23, (Cleaning and Painting New Structural Steel) and shall be measured in conformance with SSPC-PA 2. With the exception of Paint System H, all edges, corners, crevices, rivets, bolts, nuts and washers shall be stripe coated prior to the application of the primer and intermediate coats. Stripe coats shall be applied by brush or dauber. For Paint System H, only Coat III shall be stripe coated.

D. Each coat shall be free of shadow-through, skips, misses and thin or heavy coating thickness. All defects shall be repaired prior to the application of the next coat at no additional cost to the City. The steel shall be kept dust free during painting operations, and care shall be taken to protect newly coated surfaces from cleaning operations. When an area that had previously been cleaned or painted becomes soiled, contaminated or rusted, the area shall be recleaned to the specified condition and completely recoated at no additional cost to the City.

E. Each coat shall be applied within thirty (30) days after the prior coat unless approved in writing by the paint manufacturer. If the recoat window is exceeded, the surface shall be recleaned as approved by the paint manufacturer and the Engineer.

3.22 CONTROL OF OVERSPRAY AND SPILLS

A. The Contractor shall protect the environment from paint droplets, overspray and spills by providing containment for the paint application area, and be fully responsible for any damage resulting from wind or the cleaning and painting operations. Whenever the method of protection fails to function at the required level of efficiency during the execution of the Work, the Contractor shall immediately suspend all operations except those associated with minimizing adverse impact to the environment. Operations shall not resume until modifications have been made to correct the cause of the failure. Containment screens, curtains and tarpaulins shall be fire retardant.

B. Paint operations may be stopped by the Engineer due to wind but shall stop if the wind velocity exceeds twenty (20) mph, unless specific precautions are taken (e.g., specially designed containment system) to prevent the escape of paint droplets and overspray and the proposed methods are approved by the Engineer.

3.23 CAULKING

A. The Contractor shall caulk the following areas with a material approved by the paint manufacturer. Caulking shall be installed between the intermediate and finish coats and at no additional cost to the City:

1. Areas of plate delaminating that are one-eighth inch (1/8") or greater that cannot be cleaned and sealed during the application of the coatings.
2. Gaps between steel members that are one-eighth inch (1/8") or greater that cannot be cleaned and sealed during the application of the coatings.
3. Interface between the steel and concrete surfaces where through-girders penetrate the concrete. Caulking shall be applied to the above deck surfaces only. Below deck surfaces at the through-girder/concrete interface shall not be caulked.

3.24 DEFECTIVE WORK

The Contractor shall be responsible for the satisfactory application of paint and neither conditions during application nor laboratory acceptance of paint shall relieve the Contractor of responsibility of obtaining a satisfactory paint system. Painting shall be done in a neat and workmanlike manner. When rusting occurs or a paint coat lifts, blisters, wrinkles or shows evidence of having been applied under unfavorable conditions, the workmanship is poor, impure or unauthorized paint has been used or for any other reason the painting is unsatisfactory, the affected paint shall be removed and the steel thoroughly cleaned and repainted at no additional cost to the City. These areas shall provide a uniform appearance throughout the structure.

3.25 REPAIR OF DAMAGED COATINGS DUE TO CONTRACTOR OPERATIONS

Coatings that are damaged as a result of the Contractor's operations shall be repaired at no additional cost to the City. The Engineer shall be notified to determine the methods of cleaning and painting to be used.

3.26 FINAL IDENTIFICATION

When the final coat of paint is dry, the Contractor shall stencil on the structure a legend indicating the type of paint used in each coat and the month and year in which each application was completed. The letters of the stencil shall be two inches to two and one-half inches (2″ to 2-1/2″) high and shall be applied with black paint inside a fascia stringer near the abutment at a location selected by the Engineer. When more than one (1) paint system is used, additional stencils shall be applied.

3.27 FIELD CLEANING WASTE CONTAINMENT

The Contractor shall comply with the SSPC Guide 6 containment levels specified in the following paragraphs 3.28 and 3.29. Applicable portions of these requirements apply to shops when existing steel coated with hazardous material is being cleaned in the shop. With the exception of paint removal on the top flanges of members in preparation for deck replacement, a written containment system plan in conformance with the following paragraph 3.28 shall be provided unless otherwise directed by the Engineer.

3.28 FIELD CLEANING CONTAINMENT SYSTEM PLAN GUIDELINES

A. Refer to the aforementioned paragraph 3.27. Unless otherwise directed by the Engineer, the following submittal requirements apply when a containment system is specified, regardless of the presence of lead. Even if a written containment plan is not required, the Contractor shall still comply with the technical requirements below when containment is used. All submittals shall be provided to the Engineer. Work is prohibited until the submittals are approved by the Engineer. The following shall be provided:

1. Working Drawings of the proposed containment system, showing the design of the paint removal, containment, rigging and ventilation system (if applicable), including all calculations and assumptions. The Working Drawings shall:

    a. Indicate which structures are covered by the plans submitted and show the containment system in plan and elevation views including details of clips and hangers.
    b. Identify all containment system components on the plan sheets. Indicate the type and size of scaffolding or rigging to be used.
    c. Indicate sizes of the containment areas and when ventilation is specified, the capacity of the dust collectors, equipment data sheets and types of airflow systems to be provided including volume of air from ventilation fans and minimum velocity of air movement.

2. The containment system or equipment shall not encroach upon the minimum structure clearances shown within the Contract Documents, unless otherwise approved by the Engineer.
3. All curtains, screens, or tarpaulins used for containment shall be secured. Connections to the steel Work of the structure shall be made with clamps or other devices approved by the Engineer. Drilling holes anywhere into the existing structure or welding to the existing steel work will not be permitted. Attachments or fasteners to the structure shall not be permanent. No load shall be attached to the structure railings unless details and calculations showing the loading have been approved by the Engineer.
4. Containment curtains, screens and tarpaulins shall be fire retardant.
5. Indicate maximum permissible waste load permitted on the containment system.
6. Indicate all restrictions on the structure and if it is posted.
7. When the containment or rigging system or methods of erection will apply a load to the structure (e.g., suspended platform) the submittals shall include an analysis of the load that will be added to the existing structure by the containment system, blast waste, etc. When vehicles containing surface preparation materials (e.g., water or abrasive) or waste will be stationed on the structure, indicate allowable load and location. The load analysis shall be performed and signed and sealed by a professional engineer registered in the State of Maryland. The analysis shall ensure that the system will not induce a load on the structure that will create an overstress condition or otherwise effect the structural integrity of the structure.
8. When the containment or rigging system does not impose a load to the structure (e.g., tarpaulin materials suspended from the structure at an abutment or cables and picks used for access), a professional engineer's analysis and review of the drawings is not required.
9. All drawings requiring a professional Engineer's review and seal as defined in (g) above shall be prepared and issued in conformance with 01 33 21, (Contract

Documents, Working Drawings, Shop Drawings, and Product Data). Drawings not requiring a professional Engineer's review and seal can be provided on standard paper, but shall be neat and legible. Submit ten (10) copies of each drawing. When a professional Engineer's stamp is required, each sheet shall be signed and sealed by the professional Engineer. The submittal letter shall be on company letterhead. At least one (1) copy of the submittal shall have an original seal.

10. When the structure is over water, show a skimming boom for emergency backup.

3.29 CONTAINMENT SYSTEM REQUIREMENTS BY METHOD OF PREPARATION. Refer to aforementioned paragraph 3.27.

A. Washing. When power washing newly installed steel, coated only with inorganic zinc primer, the surfaces may be washed without any containment or collection of the water.

B. Whenever power washing is being performed on other painted surfaces, paint chips are prohibited from falling into rivers, streams, wetlands, wetland buffers or other bodies of water and when specified, from falling onto the ground. Should inadvertent spills or releases of paint chips occur, they shall be cleaned up before the end of the shift or immediately, if directed by the Engineer.

1. When power washing lead paint or inorganic zinc/vinyl systems, the containment shall conform to SSPC Class 2W. All wash water and debris shall be collected and disposed of in conformance with applicable regulations and aforementioned paragraph 3.27 and the following paragraph 3.35, respectively. Paint chips are also prohibited from falling onto the ground.
2. When power washing all other systems (systems other than inorganic zinc, inorganic zinc/vinyl or systems that contain lead), all dislodged paint chips shall be collected, but the water need not be captured. When dislodged chips are collected on containment screens suspended around and beneath the Work area, the maximum mesh size openings shall be seventeen (17) mil. When working over ground, chips may be collected from the ground in lieu of utilizing the containment screens provided all chips are collected before the end of the shift. Collected paint chips and debris shall be disposed of in conformance with applicable regulations and the following paragraph 3.35.

C. Power Tool Cleaning. Paint chips are prohibited from falling into rivers, streams, wetlands, wetland buffers or other bodies of water and when specified, from falling onto the ground. Should inadvertent spills or releases of paint chips occur, they shall be cleaned up before the end of the shift or immediately, if directed by the Engineer.

1. The containment for open power tool cleaning lead paint shall conform to SSPC Class 2P. Collected paint chips and debris shall be disposed of in conformance with applicable regulations and the following paragraph 3.35. Paint chips are also prohibited from falling onto the ground.
2. The containment for open power tool cleaning all other paint systems (systems that do not contain lead) shall conform to SSPC Class 3P. Collected paint chips and debris shall be disposed of in conformance with applicable regulations and the following paragraph 3.35. Paint chips are also prohibited from falling onto the ground. The use of vacuum-shrouded power tools may eliminate the need for the SSPC Class 3P containment if it can be demonstrated to the satisfaction of the Engineer that all paint chips and debris are sufficiently collected by the vacuum

and that escaping detached paint chips are cleaned up from the ground at the end of the shift.

D. Spot Abrasive Blast Cleaning or Brush Off Blast Cleaning. Paint chips are prohibited from falling onto the ground or into rivers, streams, wetlands, wetland buffers or other bodies of water. Should inadvertent spills or releases of abrasives or paint chips occur, they shall be cleaned up before the end of the shift or immediately, if directed by the Engineer. With the exception of new steel installed with inorganic zinc primer, the containment for spot abrasive blast cleaning or brush off blast cleaning (regardless of the presence of lead) shall comply with SSPC Class 2A. Collected paint chips and debris shall be disposed of in conformance with applicable regulations and the following paragraph 3.35. Containment for spot abrasive blast cleaning or brush off blast cleaning newly installed inorganic zinc primer shall comply with SSPC Class 3A. Collected paint chips and debris shall be disposed of in conformance with applicable regulations and the following paragraph 3.35.

E. Total Paint Removal by Abrasive Blast Cleaning. Paint chips are prohibited from falling onto the ground or into rivers, streams, wetlands, wetland buffers or other bodies of water. Should inadvertent spills or releases of abrasives or paint chips occur, they shall be cleaned up before the end of the shift or immediately, if directed by the Engineer. When totally removing any coatings by abrasive blast cleaning (regardless of the presence of lead), the containment shall comply with SSPC Class 2A. Collected paint chips, abrasives and debris shall be disposed of in conformance with applicable regulations and the following paragraph 3.35. The Contractor shall satisfy ambient air and worker exposure requirements established by the Maryland Department of the Environment and MOSH. Containment systems shall be maintained while Work is in progress and shall not deviate from the approved Working Drawings without approval of the Engineer. Public access to all rigging, scaffolding, containment systems and Work sites shall be denied at all times. When cleaning structures over water, the Contractor shall provide a skimming boom for emergency backup consisting of a float with a skirt or other approved system that shall be employed immediately to collect floating debris. The skimming boom shall be cleaned at least once a day. Upon completion of the project, skimming materials shall be cleaned or if cleaning is not possible or practical shall be disposed of as hazardous or nonhazardous waste as applicable.

3.30 WORKER PROTECTION AND EXPOSURE MONITORING

A. In addition to complying with all applicable OSHA and MOSH regulations, when the project involves coatings that contain lead, the Contractor shall provide the services of a CIH conforming to the aforementioned paragraph 3.2, A, 3 in the project and submit a Worker Protection Compliance Program as specified in the following paragraph 3.31. The CIH or a technician working under the direction of the CIH shall monitor worker exposures during paint disturbance operations at each structure and provide worker protection oversight.

B. Regardless of the presence of lead, the Contractor shall provide a hand wash station with soap and towels at each Work site. As dictated by the monitoring results and the applicable OSHA standards, the Contractor shall also provide a clean-up area with a shower, soap, hot and cold potable pressurized water; a change area with a locker for clean clothes, etc. and an approved container for collection and disposing of waste at each Work site. The hand wash and shower facilities shall be available for the Contractor's and the City's personnel. Hygiene facilities shall conform to the requirements specified in the applicable federal standards.

3.31 WORKER PROTECTION COMPLIANCE PROGRAM

A. A written Worker Protection Compliance Program is not required when the coatings being disturbed do not contain lead. When lead paint is being disturbed, the Contractor shall provide the Engineer with six (6) copies of a Worker Protection Compliance Program for worker protection. Work is prohibited until the submittals are approved by the Engineer.

B. The program shall be on company letterhead and shall conform to OSHA and MOSH (Lead in Construction Standards) and other applicable toxic metal standards. The Compliance Program shall be reviewed and signed by the CIH and at least one (1) copy of the submittal shall have an original CIH seal. The program shall include a commitment for the CIH or a person working under the direction of the CIH, to provide written certification each month that the Contractor has complied with the Worker Protection Compliance Program, including biological monitoring. The letter shall be provided to the Contractor within five (5) working days after the end of the month and the Contractor shall provide the Engineer with a copy of the letter the following workday.

3.32 ENVIRONMENTAL PROTECTION

At the end of the shift each day and upon completion of all project activities, surrounding property, concrete, pavement, slope protection, soil, water, sediment, etc., shall be cleaned free of visible project debris resultant from the cleaning and painting activities. Refer to the following paragraphs 3.33 and 3.34.

3.33 ENVIRONMENTAL PROTECTION PLAN OF ACTION

A. Refer to aforementioned paragraph 3.32. A written Environmental Plan of Action confirming that the environment is protected from contamination is required when the coatings are being abrasive blast cleaned (regardless of the presence of lead) or the coating being disturbed contains lead (regardless of the method of preparation). When a written Environmental Protection Plan of Action is required, it shall be reviewed and sealed by a CIH and shall include procedures for monitoring air, soil and water. All submittals shall be provided to the Engineer. Work is prohibited until the submittals are approved by the Engineer.

B. The Environmental Plan of Action shall include a location plan showing the type and location of high volume ambient air monitors if applicable, the procedures that will be followed for visible emissions assessments and inspections of the soil, water, surrounding property and structures, and pavement. Six (6) copies of each plan signed and sealed by the CIH shall be submitted. All submittals shall be in writing and on company letterhead. At least one (1) copy of the submittal shall have an original seal. The Environmental Plan of Action shall address the proposed procedures that will be implemented for the following as defined in the following paragraph 3.34:

1. For any paint disturbance using dry methods of preparation, the daily visual emissions observations that will be performed and the corrective action that will be implemented in the event emissions or releases occur.
2. When lead paint is being disturbed, the provisions for high volume ambient air monitoring (TSP-lead Monitoring); monitor citing, calibration, and operation; filter handling and shipping; and laboratory analysis, including the name and qualifications of the laboratory shall be used. Test results shall be reviewed and

summarized by the CIH and provided to the Contractor within five (5) days of sample collection, with copies provided to the Engineer the following workday after receipt.

3. For any paint disturbance, the visual assessments for soil/water/sediment that will be undertaken each day and upon project completion together with the proposed clean-up activities will be done.
4. A commitment for the CIH or a person working under the direction of the CIH, shall be included to provide a written certification within five (5) days after the end of the month that the Contractor has complied with the environmental protection plan of action and that a copy of the letter will be provided to the Engineer the following work day after receipt.

3.34 METHODS FOR ASSESSING EMISSIONS

A. Refer to aforementioned paragraph 3.32. Unless otherwise directed in the Contract Documents or by the Engineer, the following requirements apply to all projects, regardless of the presence of lead:

1. SSPC Level 1 Visible Emissions. The following Level 1 visible emissions criteria apply when any paint (lead or nonlead) is being disturbed by dry methods such as blast cleaning, power tool cleaning, etc.
2. Level 1 Emissions are defined as random visible emissions of a cumulative duration of no more than one percent (1%) of the workday or approximately five (5) minutes in an eight (8) hour day. Level 1 is required for all structures. The Contractor's QC person or Competent Person in the case of lead projects shall perform a minimum of two (2), fifteen (15) minute documented observations during each work shift. In addition to the fifteen (15) minute observations, all Contractor personnel shall be directed to routinely observe the Work area and to report unacceptable emissions to QC or supervisory personnel, or to the competent person. When unacceptable emissions are detected, the source of the emissions shall be located and immediately corrected. Records shall be retained on site and made available to the Engineer.
3. The visible emissions criteria are not required when the paint is being cleaned or disturbed using water. When water is used on existing coatings that contain lead or inorganic zinc/vinyl systems, all water shall be collected and emissions are prohibited. When water is used to clean all other coating systems, the water need not be collected and emissions are not restricted.
4. Ambient Air Monitoring. Unless otherwise directed by the Engineer, ambient air monitoring shall be required when the coatings being disturbed contain lead and the paint removal operations are located within five hundred (500) ft of houses, schools, parks, playgrounds, shopping areas or similar areas of public exposure.

    a. Abrasive Blast Cleaning. Daily ambient air monitoring at each structure being abrasive blast cleaned shall begin one (1) day prior to beginning Work and during the first ten (10) days of productive abrasive blast cleaning operations. When the results indicate that the containment is controlling emissions, full-time monitoring may be discontinued unless otherwise directed by the Engineer. However, monitoring shall be repeated for two (2) consecutive days every month thereafter during the work shift while blast cleaning or other dust producing operations are underway.

1) When the results of the original ten (10) days of monitoring or the periodic monthly tests are unacceptable, monitoring shall continue full time. Monthly monitoring shall be initiated or resume only upon approval of the Engineer and only after the results of the testing indicates that the containment is controlling emissions.

2) Monitoring shall also be resumed at the direction of the Engineer when unacceptable visible emissions or residues are observed on the ground or water. The additional monitoring shall be performed at no additional cost to the City.

a. Hand and Power Tool Cleaning. Daily ambient air monitoring at each structure shall begin one (1) day prior to beginning Work and during the first five (5) days of hand tool cleaning or power tool cleaning. When the results indicate that the containment is controlling emissions, unless otherwise directed by the Engineer, full-time monitoring may be discontinued. Monitoring shall be resumed when visible residues are observed on the ground or in the water, or visible dust is observed exceeding the Visible Emissions criteria established above. The additional monitoring shall be performed at no additional cost to the City.

b. Monitor Placement and Reporting. Total suspended particulate (TSP) monitors shall be placed in areas of potential public exposure (e.g., adjacent to homes, businesses, parks or pedestrian walkways) that are within five hundred (500) ft of each project site during cleaning operations in conformance with Method D of SSPC Guide 6. The CIH shall provide for Engineer acceptance, the proposed monitoring locations in advance, together with the rationale for the selection of each site. Monitoring shall be conducted a minimum of seven (7) hours per work shift. All TSP monitoring samples shall be analyzed using an applicable method by a laboratory approved by the American Board of Industrial Hygiene.

1) The CIH shall use an Adjusted Daily Allowance (ADA) as described in SSPC Guide 6 (not an average daily allowance) for evaluating the TSP monitoring results. The CIH or a person working under the direction of the CIH, shall provide the Contractor with a written report and analysis of monitoring results, including the relevant acceptance criteria based on the ADA, within five (5) days of sample collection. The Contractor shall provide the results to the Engineer the following workday after receipt from the CIH.

5. Removal of Visible Project Debris. At the end of the shift each day and upon completion of all project activities, surrounding property, concrete, pavement, slope protection, soil, water, sediment, etc., shall be cleaned free of visible project debris.

6. Paint chips and abrasives shall not become deposited onto surrounding property, concrete, pavement, slope protection, soil, water, or sediment, etc. Releases or spills of dust and debris that have become deposited on surrounding property, structures, equipment or vehicles, or bodies of water are unacceptable. When there are spills or releases, the Contractor shall immediately shut down the emissions producing operations, clean up the debris and change work practices, modify the containment or take other appropriate corrective action as needed to prevent similar releases from occurring in the future. Water used for washing lead paint or existing inorganic zinc/vinyl systems shall be contained and collected.

Water used to wash all other paint systems need not be contained and may contact the ground and water.

3.35 FIELD CLEANING WASTE DISPOSAL

A. All project waste, regardless of the presence of lead, shall be stored in roll-offs or sealed fifty-five (55) gallon drums. Containers shall be labeled with the structure number, Contract number, Contractor's name, contents and the date. Refer to the paragraphs 3.36 thru 3.41.

B. When the waste is hazardous, the Contractor shall comply with SSPC Guide 7. Each day the Contractor shall collect the clothing and other waste material in approved containers and seal them. When drums are used they shall be sealed fifty-five (55) gallon open head type drums conforming to I.C.C. Specification 17-H. All containers shall be in new condition and approved for use by the Engineer.

3.36 WASTE HANDLING PLAN OF ACTION

A. Refer to aforementioned paragraph 3.35. A Waste Handling Plan of Action is required for the handling, storage and disposal of all hazardous waste, regardless of the presence of lead. All submittals shall be provided to the Engineer. Work is prohibited until the submittals are approved by the Engineer. Six (6) copies of the Plan of Action shall be provided in writing and on company letterhead. When the project involves the removal of lead paint, the program shall be signed and sealed by the CIH. At least one (1) copy of the submittal shall have an original seal.

B. The Plan of Action shall address the following:

1. Names, addresses and licenses for the proposed hazardous waste transporters and disposal facilities.
2. Hazardous waste handling and storage procedures.
3. Waste and waste water sampling and analysis procedures.
4. All test results shall be provided to the Engineer within five (5) days of sample collection.

3.37 WASTE SAMPLING AND ANALYSIS

A. Refer to aforementioned paragraph 3.35. When the project involves hazardous waste, the Contractor's CIH or an employee working under the direct supervision of the CIH, shall take a minimum of four (4) samples of the accumulated residues of each waste stream collected at each structure or a sample from every third drum, whichever is greater. All sampling shall be random and representative.

B. The samples shall be analyzed for TCLP as outlined in COMAR 26.13.02 and the EPA Test Procedure Manual. Waste shall not accumulate longer than thirty (30) days before sampling. The representative samples collected shall be analyzed by an approved laboratory and the results returned to the Engineer within five (5) working days of collection. Additional samples may be required if the average test results for lead exceed 3.5 mg/l. For allowable concentrations of other heavy metals, refer to COMAR and EPA procedures. The disposal method will be based on the results of these analyses, except

that waste generated using steel abrasives shall be handled, stored and disposed of as hazardous waste regardless of the test results.

3.38 TEMPORARY WASTE STORAGE SITE

A. Refer to aforementioned paragraph 3.35. At the end of each working day, the Contractor shall haul the waste material away from the Work site to an approved temporary storage site that has been obtained by the Contractor and approved by the Engineer. The storage site shall be capable of preventing the migration of the contaminated material into the environment.

B. The storage area shall provide protection from vandalism and unauthorized access by the general public. The waste shall be removed from the temporary storage site within seventy-five (75) days from the initial date of accumulation or before the completion of Work, whichever comes first. When the Contract Documents specify that the Contractor's waste containers shall be stored at a particular facility owned by the City, the Contractor shall contact that facility to schedule delivery.

3.39 WASTE WATER DISPOSAL

A. Refer to aforementioned paragraph 3.35. Wastewater collected from bridge washing and hygiene facilities shall be tested for heavy metals (e.g. lead, arsenic, cadmium, etc.). Tests shall be performed using EPA methods by a laboratory approved by the American Board of Industrial Hygiene.

B. The Contractor shall provide the Engineer with the test results and written plans for the disposal of the water, including the name and address of the licensed transporter and disposal facility that will be used. If the local publicly owned treatment works (POTW) authorizes the disposal of the water down the sanitary sewer system, the Contractor shall provide the Engineer with a letter from the POTW authorizing the disposal.

3.40 HAZARDOUS WASTE TRANSPORTATION AND DISPOSAL

A. Refer to aforementioned paragraph 3.35. Maryland law provides that when samples tested using TCLP exceed the threshold value (e.g. five (5) mg/l for lead), they shall be considered hazardous waste and shall be removed under manifest by a licensed hazardous waste transporter to a permitted disposal facility. When tested waste material is determined to be hazardous waste, the Contractor shall request through the Engineer an EPA identification number as specified in COMAR 26.13.03.03. The Contractor shall provide the Engineer with written plans for the transportation and disposal of the waste, including the name and address of the licensed transporter and disposal facility.

B. Waste containing less than the threshold value by the TCLP test, including the confidence interval, shall be disposed of in conformance with the following paragraph 3.41.

C. The Contractor shall prepare a manifest for hazardous waste to be transported from the approved temporary storage site. The manifests shall be prepared and shall contain the information stipulated in COMAR 26.13.03.04 and as otherwise required by State regulations. The manifests shall be forwarded to the Engineer.

D. Drums of other wastes, such as solvent contaminated rags, disposable protective clothing, disposed dust collector filters and other contaminated substances shall be sampled individually and tested appropriately.

E. COMAR 26.13.03.05, stipulates the "Pre-Transport" requirements and the amount of time permitted for the accumulation of hazardous waste. Waste shall be transported by a certified waste hauler to any landfill permitted to accept this material.

F. The Contractor can obtain a list of certified haulers and other information regarding handling and disposal of blast waste by contacting the Department of Environment, Hazardous Waste for the City.

3.41 NONHAZARDOUS WASTE DISPOSAL

Refer to aforementioned paragraph 3.35. Waste containing less than the threshold value (refer to aforementioned paragraph 3.40) by the TCLP test, including the confidence interval, may be disposed of as an industrial waste at any landfill permitted to accept this material. All waste shall be disposed of in conformance with Federal, State, County and local regulations.

PART 4 MEASUREMENT AND PAYMENT

A. The Contract Unit Price for the item specified in the Contract Documents will be full compensation for all permits, Working Drawings, daily quality control records, professional Engineer's services used for containment, industrial hygienist services, air monitoring, sampling and testing materials for lead and heavy metal content, including any revisions, resubmissions of the containment plan and systems that may be required during the execution of the Work, and all other incidentals necessary to complete all cleaning and painting operations including providing safe access for inspections, flood lighting, test plates, drums, collection and storage at the temporary storage site, hauling and disposal at an approved industrial waste site or hazardous waste site, removing and replacing planking, removal of debris, and all material, labor, equipment (including test equipment), tools, and incidentals necessary to complete the Work.

B. Cleaning and painting new structural steel will not be measured but the cost will be incidental to the pertinent Structural Steel or Repair item.

C. Cleaning and painting existing structural steel will not be measured but will be paid for at the Contract lump sum price for the pertinent Cleaning and Painting item.

D.

E. All costs associated with repair of existing coatings due to new connections and existing coatings damaged during steel/deck repairs will not be measured but will be incidental to the pertinent Repair, Structural Steel, or Cleaning and Painting items included in the Contract Documents.

DIVISION 10
SPECIALTIES
10 14 00 SIGNAGE

10 14 15.01 BRIDGE MOUNTED SIGN SUPPORTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and constructing bridge mounted sign supports and sign luminaire supports as specified in the Contract Documents. The Work does not include sign panels, electrical Work, and luminaires.

PART 2 PRODUCTS

2.1 MATERIALS

A. Epoxy Grout. Epoxy grout shall consist of sand and epoxy mixed by volume in conformance with the manufacturer's recommendations. The grout shall be capable of developing a minimum compressive strength of sixty-five hundred (6500) psi in seventy-two (72) hours when tested as specified in Maryland Standard Methods of Testing (MSMT) 501. Sand for epoxy grout shall conform to 31 62 13.21, (Protective Jackets for Piles) Part 2.1.

B. Structural Steel: Structural steel shall conform to the requirements specified in the Contract Documents. All primary load carrying members shall conform to the supplementary toughness requirements of M 270, Zone 2. Primary load carrying members are as follows or as designated in the Contract Documents: Finger joint steel from which saw tooth configurations have been cut, all stringers, cover plates, bearing stiffeners, splice plates, pins and pin links for straight rolled steel beam bridges; all flanges, webs, bearing stiffeners, splice plates, pins and pin links for straight steel girder bridges. Additionally, on curved rolled steel beam and steel girder bridges; all diaphragms, cross frames, lateral bracing, including connection plates to main stringers.

C. Anchor Bolts, Nuts and Washers. Bolts, nuts and washers for general use shall conform to A 307, and shall be galvanized as specified in A 153. Anchor bolts shall be galvanized and shall conform to A 709, Grade 36.

D. High Strength Bolts, Nuts and Washers: High strength bolts, nuts and washers shall conform to A 325.

E. Paint. Paint System B shall conform to the following:

PAINT SYSTEMS TABLE

PAINT	COAT	SECTION	DRY FILM THICKNESS, mils, min - max	USAGE
SYSTEM B				
Inorganic Zinc	I	912.02.01	3.0 – 5.0	Shop Primer
Epoxy Polyamide	II	912.03.02	5.0 – 8.0	First Field Cover-All Coat
Aliphatic Urethane	III	912.04.02	2.0 – 3.0	Finish Coat

F. On new structures, the structural steel and fasteners for the sign support shall be the same as used for the fabrication of the structure on which it is to be mounted, including the additional requirements for Charpy V-notch testing. When A 709, Grade 50W structural steel is used, the vertical supports shall be made of steel conforming to A 709, Grade 36 or 50.

G. On existing structures, the structural steel for the sign support shall include the additional requirements for Charpy V-notch testing and conform to A 709, Grade 36 or 50. When the existing structure consists of A 709, Grade 50W structural steel, the structural steel for the sign support shall conform to A 709, Grade 50W, except that the vertical supports shall be made of steel conforming to A 709, Grade 36 or 50. The fasteners shall conform to 909.07 and shall be Type 3 when used with A 709, Grade 50W structural steel.

H. Vertical supports to which the sign panels are attached shall be galvanized in conformance with A 123. All bolts, nuts, and similar fasteners in contact with the galvanized material shall be mechanically or hot-dipped galvanized. The coating shall conform to the thickness, adherence, and quality requirements of A 153.

PART 3 EXECUTION

A. Construction shall conform to 05 12 00, (Structural Metal Framing—Metal Structures). Painting shall conform to 09 97 13.23, (Cleaning and Painting New Structural Steel), except as otherwise specified herein.

B. The Contractor shall set the anchor bolts by epoxy grouting or casting in place when applicable.

C. On new structures the nongalvanized portions of the sign support shall be cleaned and painted in conformance with the system specified for the structure on which it is to be mounted. Portions of the sign support mounted on structures constructed with Grade 50W steel, and attached to areas that are to be painted, shall also be cleaned and painted.

D. On existing structures not constructed with Grade 50W structural steel, the Contractor may elect to galvanize the entire sign support or paint those areas not designated to be galvanized. The nongalvanized portions of the sign support shall be cleaned and painted as specified in 09 97 13.23, (Cleaning and Painting New Structural Steel). They shall be blast cleaned to conform to the surface condition of near white SA 2-1/2 prior to painting.

E. Portions of the sign support mounted on existing structures constructed with Grade 50W steel, and attached to areas that are painted shall also be cleaned and painted.

PART 4 MEASUREMENT AND PAYMENT

Bridge Mounted Sign Supports will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

10 14 15.02 CONCRETE FOUNDATIONS FOR TRAFFIC SIGNALS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing concrete foundations for installing traffic signals, highway lighting and signs at locations specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Materials shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

B. Concrete Mix No. 2 shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

C. Reinforcement Steel shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Concrete Pavements).

D. Anchor Bolts. High strength bolts; nuts and washers shall conform to A 325.

E. Conduit. Conduit shall conform to the following:

1. Metallic Conduit.

MATERIAL	SPECIFICATION
Electrical Metallic Tubing	UL 797
Intermediate Metal Conduit	UL 1242
Rigid Metal Conduit	UL 6
Rigid Steel Conduit, Zinc Coated	ANSI C80.1
Metallic Outlet Boxes	UL 514A
Fittings for Conduit and Outlet Boxes	UL 514B

2. Nonmetallic Conduit. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Each length shall be stamped or embossed with the grade or type and applicable UL or NEMA designation.

MATERIAL	SPECIFICATION
Schedule 40 and 80 Rigid Polyvinyl Chloride (PVC) Conduit	UL 651
Electrical Plastic Tubing (EPT) and Electrical Plastic Conduit (EPC-40 and EPC-80)	NEMA TC 2
Nonmetallic Outlet Boxes, Flush Device Boxes and Covers	UL 514C
Electrical Nonmetallic Conduit (ENC)	NEMA TC 13
PVC Fittings for use with Rigid PVC Conduit and Tubing	NEMA TC 3
Flexible PVC Coated Conduit	UL 360
Liquid Tight Flexible Nonmetallic Conduit for Detector Sleeves	UL 1660

3. PVC Coated Metallic Conduit.

MATERIAL	SPECIFICATION
PVC Externally Coated, Galvanized, Rigid Steel Conduit and Electrical Metallic Tubing	NEMA RN 1

F. Galvanizing for hardware shall conform to A 153.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall perform all excavation to the dimensions specified in the Contract Documents. All excavation Work will be inspected and approved by the Engineer before proceeding with construction.

3.2 GALVANIZED PARTS

Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in A 780.

3.3 CONCRETE PLACEMENT

A. It is intended that all concrete be placed against undisturbed earth. However, where the existing ground will not retain its shape during or after excavation or if the excavation should show any tendency to cave in before placing the foundation, the Contractor shall provide and install a corrugated metal pipe to retain the earth and receive the concrete. The pipe shall remain in place.

B. Concrete shall be mixed, placed and tested as specified in 03 30 00, (Portland Cement Concrete Structures). Footings including reinforcement and bolt circle data shall be as specified in the Contract Documents and in conformance with the approved Work.

C. Drawings. Anchor bolts shall be plumb. Suitable templates for setting anchor bolts shall be accurately placed and left in place until the concrete has attained its initial set.

D. Tops of foundations shall be troweled to a dense smooth finish. Exposed surfaces shall be cured by use of a liquid membrane-curing compound.

3.4 UNUSUAL SOIL CONDITIONS.

When unexpected subsurface conditions are encountered, the excavation depth shall be modified as directed by the Engineer. Rock or boulders, which cannot be removed by ordinary means, shall be removed to the levels and dimensions specified in the Contract Documents or to a depth necessary to obtain the required stability as directed by the Engineer.

3.5 BACKFILL

Material used for backfill shall be free of topsoil, organic, frozen or other undesirable material. Spaces to be backfilled shall be kept free of trash and shall be cleaned before backfill is placed. Backfill material shall be suitable material from the excavation or other sources conforming to 31 24 13.10, (Embankment and Subgrade). All backfill shall be compacted in layers not exceeding 8 inches (8″) loose thickness. Compaction shall be done with mechanical or vibratory compaction equipment to obtain at least ninety-two percent (92%) of maximum density at moisture content within two percent (2%) of the optimum in conformance with T 180, Method C.

PART 4 MEASUREMENT AND PAYMENT

A. Concrete foundations for installing traffic signals, highway lighting and signs will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent Concrete Foundation item. The payment will be full compensation for all concrete, excavation, corrugated metal pipe or forms, reinforcement steel, anchor bolts, backfill and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. When concrete barrier transitions, conduit and grounding are required, they will be measured and paid for as specified in 34 71 13.24 (Concrete Traffic Barriers), 10 14 15.03 (Galvanized Steel Beam Sign Posts), 10 14 15.04 (Overhead Sign Structures), 26 44 00 (Grounding), 26 07 01.01 (Electrical Conduit and Fittings), 34 41 16.08 (Traffic Control Device Cabinets and Equipment) and 34 41 13.10 (Signal Structures).

10 14 15.03 GALVANIZED STEEL BEAM SIGN POSTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing galvanized steel beam sign posts as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bolts, Nuts and Washers shall conform to 10 14 15.02, Part 2, (Concrete Foundations for Traffic Signals).

B. Galvanizing for beams shall conform to A 123.

C. Galvanizing for hardware shall conform to A 153.

D. Steel Beams shall conform to A 709.

PART 3 EXECUTION

A. Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in A 780.

B. Galvanized steel beam sign posts shall be placed in the ground in a plumb position to the lateral orientation specified in the Contract Documents.

C. Each location where galvanized steel beam sign posts are to be installed shall be staked out by the Contractor and approved by the Engineer. After staking out the galvanized steel beam sign posts and obtaining approval for their location from the Engineer, the Contractor shall submit Working Drawings and upon approval, be permitted to order materials. The Contractor shall indicate on the Working Drawings the highest elevation of the traveled roadway and the shoulder elevation where sign posts will be installed.

PART 4 MEASUREMENT AND PAYMENT

A. Galvanized Steel Beam Sign Posts will be measured and paid for at the Contract Unit Price per linear foot for the various sizes of posts specified in the Contract Documents. The payment will be full compensation for stakeout, furnishing and installing the posts and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Breakaway Base Support Systems, when specified in the Contract Documents, will be measured and paid for as specified in 10 14 15.08, (Breakaway Base Support Systems).

10 14 15.04 OVERHEAD SIGN STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and fabricating overhead sign structures and other appurtenances as specified in the Contract Documents or as directed by the Engineer. Sign panels, electrical Work, luminaires and foundations are excluded.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bolts, Nuts and Washers. High strength bolts; nuts and washers shall conform to A 325.

B. Overhead Sign Structures. Structural steel shall conform to A 709, Grade 36; steel tubes or pipes shall conform to A 595, Grade A or API 5-LX52. Design and minimum thickness of material shall conform to AASHTO Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. All steel shall be galvanized as specified in A 123. Hardware shall be galvanized as specified in A 153.

PART 3 EXECUTION

A. All fabrication shall be done in the shop as specified in 05 12 00, (Structural Metal Framing-Metal Structures), except that welding shall conform to ANSI/AWS D1.1, Tubular Structures.

B. All assemblies and tubular members shall be designed and manufactured as specified in A 385 to permit hot dip galvanizing. All holes required in the supports shall be made before galvanizing. The surfaces shall be protected during transportation and handling.

C. The structure shall be free from sharp edges, irregularities, misfits or structural deficiencies. After erection and before final acceptance, the Contractor shall repair or replace damaged surfaces in a manner acceptable to the Engineer.

D. Each location where overhead sign structures are to be installed shall be staked out by the Contractor and approved by the Engineer. After staking out the overhead sign structures and obtaining approval for their location from the Engineer, the Contractor shall submit Working Drawings and upon approval be permitted to order materials. The Contractor shall indicate on the Working Drawings the highest elevation of the traveled roadway and the shoulder elevation where sign structure supports will be installed.

PART 4 MEASUREMENT AND PAYMENT

Overhead Sign Structures will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for all stakeouts, overhead sign structures, sign/luminaires supports, nuts and washers, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work

10 14 15.05 WOOD SIGN SUPPORTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and erecting wood sign supports as specified in the Contract Documents or as directed by the Engineer. Signs shall be as specified in 10 14 53, (Signs).

PART 2 PRODUCTS

2.1 MATERIALS

A. Wood supports shall be No. 1 dense grade.

B. Wood. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Structural timber and lumber shall conform to M 168.

C. Preservatives. Preservatives and pressure treatment for timber shall conform to M 133.

PART 3 EXECUTION

A. Wood sign supports shall be placed in the ground in a plumb position to the depth and lateral orientation specified in the Contract Documents. Backfill shall consist of suitable excavation material compacted in place. Holes for embedding sign supports shall be augered or dug, using methods approved by the Engineer. Driving or hammering wood sign supports into undisturbed earth is prohibited.

B. When specified in the Contract Documents, wood sign supports shall have drilled holes conforming to the breakaway requirements specified in AASHTO Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, or as indicated in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

Wood Sign Supports will be measured and paid for at the Contract Unit Price per linear foot for the length and size specified in the Contract Documents. The payment will be full compensation for all excavation and backfill, drilled holes and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

10 14 15.08 BREAKAWAY BASE SUPPORT SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing breakaway base support systems or installing City furnished breakaway base support systems as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

Breakaway base support systems shall conform to the breakaway requirements specified in AASHTO Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals as approved by the City.

PART 3 EXECUTION

A. The Contractor shall furnish and install breakaway base support systems for signals, lighting and signing, including post hinge assembly units for sign structures, as specified in the Contract Documents and in conformance with the manufacturer's recommendations. The ground adjacent to the breakaway base shall be graded as specified in the Contract Documents.

B. The concrete foundation shall conform to 10 14 15.02, (Concrete Foundations for Traffic Signals).

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, backfill, grading and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Breakaway Base Support Systems will be measured and paid for at the Contract Unit Price per each for breakaway support systems furnished and installed as specified in the Contract Documents.

C. Installation of City supplied breakaway support systems will be measured and paid for at the Contract Unit Price per each. Transportation to and pick up of the City supplied components will not be measured but the cost will be incidental to this item.

D. Breakaway base support systems for signals. Refer to 34 41 13.10, Part 4, (Signal Structures) and 10 14 15.08, (Breakaway Base Support System).

10 14 15.09 REMOVE AND RELOCATE EXISTING SIGNS AND SIGN STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of removing and relocating existing signs and sign structures as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 GENERAL

All existing cable shall be made safe in conformance with the appropriate electrical codes and as directed by the Engineer.

3.2 REMOVING EXISTING SIGNS

A. Existing signs may be relocated during construction. All existing and relocated signs shall be removed when the new signing system is installed. All new signs in a particular sequence giving similar directions shall be installed before existing signs are removed.

B. Concrete foundations remaining after removing the sign structure shall be removed as specified in 02 41 13.14, Part 3, (Minor Selective Site Demolition). All holes left after sign removal shall be backfilled, compacted and restored to conditions similar to its surroundings as approved by the Engineer.

3.3 RELOCATING EXISTING SIGNS

A. Existing signs specified in the Contract Documents shall be relocated as part of the new signing system. Concrete foundations remaining after relocating the sign shall be removed as specified in 02 41 13.14, Part 3, (Minor Selective Site Demolition).

B. The Contractor shall be responsible for the storage and handling of materials to be reused.

C. Materials shall be so stored as to assure the preservation of their quality and acceptability for the Work. Stored materials may again be inspected prior to their use in the Work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the right-of-way or project site may be used for storage purposes. Storage areas must be restored to their original condition by the Contractor at its expense. Any additional space required must be provided by the Contractor at its expense.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for removing and relocating existing signs and sign structures, removing existing concrete foundations, backfilling and compacting existing holes left after foundation removal and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Remove Existing Ground Mounted Signs and Supports will be measured and paid for at the Contract Unit Price per square foot area of the sign. Removal of sign supports and concrete foundations will not be measured but the cost will be incidental to the Contract Unit Price for removing the signs.

C. Remove Signs from Existing Overhead Structure will be measured and paid for at the Contract Unit Price per square foot area of the sign. Removal of sign and sign luminaire supports, luminaires, conduit and cable will not be measured but the cost will be incidental to the Contract Unit Price for removing the signs.

D. Relocate Existing Ground Mounted Signs will be measured and paid for at the Contract Unit Price per square foot area of the sign. Removal and disposal, or removal and relocation of the sign support will not be measured but the cost will be incidental to the Contract Unit Price for relocating the signs.

E. Relocate Signs from Existing Overhead Structure will be measured and paid for at the Contract Unit Price per square foot area of the sign. Removal and relocation of sign and sign luminaire supports and luminaires will not be measured but the cost will be incidental to the Contract Unit Price for relocating the signs.

F. Remove Existing Cantilever or Overhead Sign Structure and Signs and Supports will be measured and paid for at the Contract Unit Price per each structure. Disconnecting the electrical service and removal of concrete foundations will not be measured but the cost will be incidental to the Contract Unit Price for removing the structure.

G. Concrete for sign foundation, galvanized steel beam sign posts, breakaway base support system for steel beams and wood sign supports for new sign supports, if required, will be paid for as specified in the applicable portions of 10 14 15.02 (Concrete Foundations for

Traffic Signals), 10 14 15.03 (Galvanized Steel Beam Sign Posts), 10 14 15.05 (Wood Sign Supports) and 10 14 15.08 (Breakaway Base Support Systems).

10 14 53 TRAFFIC SIGNS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing and installing signs of sheet aluminum or extruded aluminum panels, all with a reflective or nonreflective sheeting background, and all direct applied or silk screened copy or demountable copy with bolts and fittings to erect the signs as specified in the Contract Documents or as directed by the Engineer. Sign supports shall be as specified in 10 14 15.03 (Galvanized Steel Beam Sign Posts), 10 14 15.04 (Overhead Sign Structures) and 10 14 15.05 (Wood Sign Supports).

B. The sign installation shall include clearing Work to provide for good sight distance.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sign Panel Supports and Hardware shall conform to A 123, A 153 and A 709 and the following:

1. High strength bolts; nuts and washers shall conform to A 325.
2. Structural timber and lumber shall conform to M 168.
3. Preservatives and pressure treatment for timber shall conform to M 133.
4. Structural steel shall conform to A 709, Grade 36; steel tubes or pipes shall conform to A 595, Grade A or API 5-LX52. Design and minimum thickness of material shall conform to AASHTO Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals: All steel shall be galvanized as specified in A 123. Hardware shall be galvanized as specified in A 153.

B. Reflective and Nonreflective Sheeting: Unless otherwise specified in the Contract Documents, retroreflective sheeting for signs shall conform to (2). Retroreflective sheeting for channelizing devices shall conform to (2) or (6).

1. Type II Retroreflective Sheeting. When specified in the Contract Documents, engineering grade retroreflective sheeting shall conform to D 4956, Type II.
2. Type III Retroreflective Sheeting. Type III retroreflective sheeting shall conform to D 4956, Type III and the following

MINIMUM REFLECTIVE INTENSITY VALUES FOR TYPE III SHEETING Minimum Coefficient of Retroreflection (R_A) cd/(lx · m^2)								
Observation Angle°	Entrance Angle°	Silver White	Yellow	Red	Orange	Green	Blue	Brown
0.2	+50	75	40	8.4	25	10.3	2.9	1.6
0.5	+50	35	20	6.8	10	6.4	2.0	1.1

3. "The Contractor shall furnish certification that the reflective sheeting conforms to these requirements for each batch. The certificate shall verify that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.
4. High Performance Wide Angle Retroreflective Sheeting. High performance wide angle retroreflective sheeting shall conform to D 4956, and the following:

MINIMUM REFLECTIVE INTENSITY VALUES FOR HIGH PERFORMANCE WIDTH ANGLE PRISMATIC LENS SHEETING **Minimum Coefficient of Retroreflection·(R_A) cd/(lx · m^2)**								
Observation Angle°	Entrance Angle°	White	Yellow	Red	Orange	Green	Blue	Fluorescent Orange
0.2	- 4	800	660	215	450	75	43	200
0.2	+30	400	340	100	250	30	20	120
0.2	+50	35	23	6.6	16	1.8	1.0	50
0.5	- 4	200	160	45	120	18	9.8	80
0.5	+30	100	85	26	70	10	5.0	50
	+50	30	20	6.4	16	2.5	2.0	20

5. Temporary Traffic Signs (TTS).

   a. All rigid temporary traffic signs shall be fluorescent orange and conform to D 4956, Type VII.
   b. All temporary flexible rollup signs shall be fluorescent orange and conform to D 4956, Type VI.

6. Black Sheeting. Black sheeting shall be nonreflective.
7. Drums for Maintenance of Traffic. All drums for maintenance of traffic shall have high performance wide-angle white and fluorescent orange reboundable sheeting and conform to D 4956 Type VII.

C. Sign Materials: The manufacturer or supplier shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

1. Sheet Aluminum Sign Panels: Sign panels shall conform to B 209, with an anodized mill finish. Alloys shall be either 6061 T6 or 5052-H38.
2. Extruded Aluminum Sign Panels and Edge Strip: Extruded aluminum sign panels and edge strip shall conform to B 221, alloy 6063 T6.3.
3. Hardware: Hardware shall be clear anodized, conforming to one of the following: B 209, alloy 2024 T4; B 211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6 or 2017 T4.

D. The City will supply traffic signal related signs and their mounting hardware for span wire, mast arm, and signal pole mounted signs. All other mounting hardware shall be supplied by the Contractor and shall be manufactured from stainless steel.

PART 3 EXECUTION

A. Extruded aluminum shall have demountable copy. Sheet aluminum shall have direct applied or silkscreen copy. After installation of the signs is completed, they will be inspected. If specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor as directed by the Engineer.

B. Each new sign location shall be inspected to determine if clearing is required. All clearing and disposal shall be done as specified in 31 11 00, (Clearing and Grubbing). Any tree limbs protruding within the limits of clearing shall be removed as specified in 31 13 16, (Selective Tree Trimming). The limits of clearing for each location shall be as specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

A. Signs will be measured and paid for at the Contract Unit Price per square foot of area of the vertical front face of the completed sign with no deduction for required shaping. The payment will be full compensation for the mounting hardware and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. City furnished signs and mounting hardware will be measured and paid for at the Contract Unit Price per square foot for the completed sign installed. The payment will be full compensation for all transportation, drilling holes as specified, installation, and for all materials, labor, equipment, tools, and incidentals necessary to complete the Work.

C. Clearing for signing will not be measured but the cost will be incidental to the Contract Unit Price for furnishing and installing the signs.

10 14 53.01 TRAFFIC CONTROL — ELECTRICAL CABLE, WIRE AND CONNECTORS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing loop detector wires and leads, electrical cable, cable ducts, wire, micro-loop probe sets, communication cable and associated connectors of the type and at the locations specified in the Contract Documents, or as directed by the Engineer, for traffic control.

PART 2 PRODUCTS

2.1 MATERIALS

A. Micro-Loop Probe shall be as approved by the Engineer.

B. Sealer for Loop Detector. Sealing material to seal saw cuts for loop detector wires shall be either, Type A, two (2) part epoxy or Type B, one (1) part polyurethane. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The

contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. No aggregate shall be mixed with the sealer material. The sealer shall be applied in conformance with the manufacturer's recommendations. Tests shall conform to the following:

TYPE A – TWO PART EPOXY	
TEST AND METHOD	**SPECIFICATION LIMITS**
Viscosity, cone and plate Viscometer@ 25° C, cps max	12,000
Pot life @ 25° C, minutes minimum	10
Cure time @ 25° C, no tackiness, hr max	1
Hardness, Type A durometer, D 2240	50 – 60
Tensile elongation, D 638, % minimum	100
Water absorption, D 570, %/24 hr max	0.5
Oil absorption, D 471, % max	0.02
Volume resistivity @ 25° C, D 257, ohm-cm minimum	2.4×10^{10}

TYPE B – ONE PART POLYURETHANE	
TEST AND METHOD	**SPECIFICATION LIMITS**
Viscosity, Brookfield RVF #6 spindle @ 20 rpm 25° C, cps max	30,000
Cure time @ 25° C, no tackiness, hr max	24
Hardness, Rex Type A, minimum	50-60
Tensile strength, D 412, psi minimum	500
Tensile elongation, D 412, % minimum	300
ARC resistance, D 495, sec minimum	70
Dielectric constant, D 150, minimum	6 @ 50 Hz 4.25 @ 500 kHz
Nonvolatile content, %	85

C. Conduit shall conform to 10 14 15.02, Part 2.1.

D. Electrical Cable and Wire: Electrical cable and wire shall be the standard commercial product of the manufacturer and shall have been manufactured not more than one (1) year prior to the date of the Contract. All cable and wire shall be made of copper.

1. Direct Burial Cable: Direct burial cable shall be single conductor, stranded, with an unshielded, chemically crosslinked thermosetting polyethylene insulation, rated for six hundred (600) volts. The cable shall be suitable for direct earth burial or installation in ducts or conduit and shall conform to Underwriters' Laboratories Type USE, XHHW or THW and shall bear the applicable UL labels denoting type, size, stranding, manufacturer's name and surface marking or molded ridges for phase and neutral identification. Sizes shall be as specified in the Contract Documents.
2. Building Cable and Wire: Building cable and wire shall be six hundred (600) volt, plastic insulated, nylon jacketed and shall conform to Underwriters' Laboratories Type THWN/THHN and shall bear the applicable UL labels denoting type, size, stranding, manufacturer's name and surface marking or molded ridges for phase and neutral identification. Sizes shall be as specified in the Contract Documents.
3. Cable Duct: Cable duct shall consist of cables preinstalled in either a polyvinyl chloride (PVC) or polyethylene (PE) plastic duct conforming to NEMA TC 7 and the NEC. PVC shall conform to D 3485. PE duct shall be manufactured from black,

virgin, high density PE resin conforming to D 1248, Type III, Grade P34, Class C, Category 5. Minimum inside diameter of duct shall be one and one-half inches (1 1/2″). Cable shall be rated for 600 volts.

4. Ground Wire and Rods: Ground wire shall be bare medium drawn copper. Ground wire installed underground shall be of the size (solid or stranded) configuration shown in the Contract Documents. Ground rods shall be three quarters inch (0.75″) diameter, a minimum of ten feet (10′) in length, with a steel core and copper jacket.
5. Traffic Signal Cable: Traffic signal cable shall conform to IMSA Specification 19-1 and shall be stranded. Conductors shall be No. 14 AWG.
6. Loop Detector Lead-In Cable: Loop detector lead-in cable shall be two (2) conductors, No. 14 AWG, PE jacketed, conforming to IMSA Specification 50-2.
7. Loop Detector Wire: Loop detector wire shall be single conductor, 600 volt, No. 14 AWG, 19-strand wire in flexible PE tubing.
8. Voice Grade Communication Cable: Self-supporting cable shall be solid No. 19 AWG and conform to IMSA 40-4. Underground cable shall conform to IMSA 60-2.
9. Electric Service Wire: Electric service wire for traffic signals, intersection control beacons, hazard identification beacons and luminaires mounted on traffic signal structures shall have three (3) individual wires. Each wire shall be seven (7) stranded. Electric service wire color identification by spray paint, tape, heat shrink tubing or any other after manufacturing method is prohibited.

E. Communication Cable shall conform to paragraph D 8 above.

F. Cable and Wire Connectors shall conform to the following:

1. Cable Connectors and Connector Kits: Cable connectors and connector kits for use in lighting structures, hand holes, junction or pull boxes, and for terminating underground cables in lighting structures shall be rated for a minimum of six hundred (600) volt service. Cable connectors shall be compression type, applied by means of a compression tool. Connectors shall be fabricated from high strength copper alloy. Plated connectors fabricated from metals other than copper are prohibited. Bolted type connectors shall be utilized for splicing bare ground conductors.
2. Connector Kit Components: Each cable connector kit shall be furnished with all component parts described under the various listed types. Each kit shall contain sufficient silicone compound to lubricate metal parts and the housing for each assembly along with complete installation instructions.

    a. All housings shall be made of water resistant synthetic rubber suitable for burial in the ground or exposure to sunlight. Each housing shall form a watertight seal around the cable at the point of disconnection and between the insert body and enveloping “Y” housing.
    b. All copper pins, sockets and fuse contacts shall have a minimum conductivity of ninety percent (90%). The crimpable portion shall be fully annealed while the rest of the device is maintained in its original state.
    c. Plastic sleeves shall be rigid, molded insulating plastic material of sufficient outside diameter to form a watertight fit with its related housing. Wall thickness shall be one-tenths inch (0.10″) maximum and sleeve lengths of four inches and seven inches (4″ and 7″) shall be available.

d. All fuses shall be rated six hundred (600) volts, one hundred thousand (100,000) amps AIC.

3. Connector Types: Each cable connector kit furnished shall be one of the following types:

a. Type I is an unfused, quick disconnect inline connector kit containing:

1) A copper pin crimpable to a conductor.
2) A receptacle having a centrally located, recessed locking socket constructed so that it is filled and retained by its housing and a disposable assembly pin.
3) A plug housing for retention of the copper pin.
4) A receptacle housing with disposable protective sleeve.

b. Type II is a fused, quick disconnect inline connector kit containing:

1) A pair of spring-loaded copper fuses contacts suitable for gripping the specified cartridge fuse. One (1) contact shall be crimpable on a conductor and after insertion into its proper position within the load side plug housing, be capable of being securely retained therein. The other contact shall be preassembled for retention within the line side of the connector body.
2) A load side housing permanently marked "Load Side."
3) A disposable assembly pin.
4) A fuse of the specified amp rating.

c. Type III is a fused, quick disconnect "Y" connector kit containing:

1) A pair of spring-loaded copper fuses contacts suitable for gripping the specified cartridge fuse. One (1) contact shall be crimpable on a conductor and after insertion into its proper position within the load
2) Side plug housing, be capable of being securely retained therein. The other contact shall be preassembled for retention within a "Y" insert body.
3) A line side "Y" housing with two (2) water seal cable ports.
4) Two (2) terminal lugs, each having a mounting hole.
5) A bolt and a self-locking nut.
6) A "Y" insert body with preassembled line side fuse contact and a ring tongue terminal.
7) A load side plug housing permanently marked "Load Side."
8) A disposable assembly pin.
9) A fuse of specified amp rating.

d. Type IV is an unfused, quick disconnect "Y" connector kit containing:

1) A copper pin crimpable to a conductor and suitable for retention in the load side receptacle housing.
2) A "Y" insert body with preassembled load side copper socket and ring tongue terminal.

3) A line side "Y" housing with two (2) water seal cable ports.
4) Two (2) terminal lugs, each having a mounting hole.
5) A bolt and self-locking nut.
6) A load side receptacle housing.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall furnish and install copper conductor wire and cable of the types and sizes and at the locations specified in the Contract Documents. No splicing will be permitted for cables unless specified in the Contract Documents. When specified, lighting cable splices and loop detector lead in cable will be permitted only in junction and pull boxes and hand holes. Cable shall not be installed until the entire related raceway, including manhole, hand hole, and foundation system is in place. A six foot (6′) cable slack shall be provided neatly tied, coiled and positioned in the bottom of the hand holes, manholes and cabinets. Drip loops measuring eight inches (8″) shall be provided at all overhead entrance points into structures. Insulated spade type terminal ends shall be installed upon all wiring placed on terminal blocks.

3.2 DIRECT BURIAL CABLE

Direct burial cable shall be installed to the depth of cover specified in the Contract Documents. Backfill shall conform to 10 14 15.02, Part 3, (Concrete Foundation for Traffic Signal).

3.3 CABLE IN CONDUITS

Cable in conduits shall be installed in a manner and by methods to prevent harmful stretching of the conductor, injury to the insulation or damage to the other protective covering. The ends of all cables shall be sealed until ready for connection. Where more than one (1) wire or cable is to be installed in a single duct or conduit, they shall be pulled into the conduits by hand or power winch with the use of cable grips or pulling eyes. Pulling tension shall be governed by recommended standard procedures for straight pulls or bends. A lubricant compatible with the cable insulation shall be used.

3.4 PREASSEMBLED CABLE DUCT

A. Prior to installation, the cable duct shall be released out from its reel as the reel is moved alongside and parallel to the trench. Cable duct shall not be pulled off a reel located in a stationary position. The cable shall be installed using cable grip in a manner that will not stress or damage conductors, insulation or sheath wall.

B. After backfilling the Contractor shall demonstrate that the conductors move freely within the duct by pulling the conductors out a minimum length of two feet (2′). Pulling tensions shall conform to manufacturer's recommendations. The cable shall then be pulled to its original position. Cable duct ends shall be completely sealed with a waterproof removable sealing compound, molded plastic or rubber device.

3.5 CABLE IN LIGHTING STRUCTURES

The cable shall be supported at each luminaire with a suitable clamp as an integral part of the luminaire or a device approved by the Engineer for the application.

3.6 IDENTIFICATION TAGS

Identification tags for circuit wiring in all hand holes, junction boxes and control cabinets shall be furnished and installed. Nonconductive identifying bands shall be nylon, self-clinching type with adequate sized tab for labeling. Each band shall be marked using 1/4 inch minimum lettering dies, engraving device or other permanent marking process approved by the Engineer. Bands shall indicate circuit number for lighting systems, terminal block position for loop detector cables and traffic signal phase for all other signal cables.

3.7 LOOP DETECTOR WIRE AND LOOP DETECTOR LEAD-IN

Prior to the installation of loop wires, the saw cut area shall be dry and free of any saw cut debris. Loop detector wire cable shall be twisted five (5) turns per foot from the loop itself to the terminal point. Loop detector wire shall be installed at the bottom of the saw cut. A blunt instrument shall be used to seat the loop detector wire at the bottom of the saw cut. Loop detector wire shall be spliced to loop detector lead-in as specified in the Contract Documents.

3.8 GROUNDING WIRE,

Refer to Section 26 44 00, (Grounding).

3.9 CONNECTOR KITS

Connector kits shall be furnished and installed as required for the types of cables specified in the Contract Documents and shall conform to the manufacturer's recommendations.

3.10 MICRO-LOOP PROBES

Micro-loop probe sets shall be installed as specified in the Contract Documents or as directed by the Engineer. All leads shall be terminated in the controller cabinet.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all cable, preassembled cable ducts, wire, lubricants, splices, overhead communication cable attachments, identification tags, trench excavation and backfill, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Electrical Cable, Cable Ducts, Loop Detector Wire and Loop Detector Lead-in Cable, Grounding Wire and Communication Cable will be measured and paid for at the Contract Unit Price per linear foot for the type and sizes specified in the Contract Documents.

C. Connector Kits will be measured and paid for at the Contract Unit Price per each type.

D. Micro-Loop Probe Sets will be measured and paid for at the Contract Unit Price per each set. The payment will be full compensation for all sealant, PVC conduit, hole drilling, installation of lead-in cable, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

E. Saw cuts for loop detector wire and micro-loop probe sets will be measured and paid for as specified in 34 01 13.15, (Saw Cuts for Traffic Control Devices).

10 14 53.10 MODIFY EXISTING SIGN MESSAGES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of removing and adding new sign copy, shields and arrows for existing signs, or overlaying existing sign messages as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Type III Refer to retroreflective sheeting and copy materials for signs shall conform to D 4956, and the following:

MINIMUM REFLECTIVE INTENSITY VALUES FOR TYPE III SHEETING Minimum Coefficient of Retroreflection (R_A) cd/(lx · m^2)								
Observation Angle°	Entrance Angle°	Silver-White	Yellow	Red	Orange	Green	Blue	Brown
0.2	+50	75	40	8.4	25	10.3	2.9	1.6
0.5	+50	35	20	6.8	10	6.4	2.0	1.1

The Contractor shall furnish certification that the reflective sheeting conforms to these requirements for each batch. Certification shall verify that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/ manufacturer's letterhead or approved document and shall be duly signed by a company officer.

B. Sheet Aluminum Sign Panels. Sign panels shall conform to B 209, with an anodized mill finish. Alloys shall be either 6061 T6 or 5052-H38.

C. Extruded Aluminum Sign Panels and Edge Strip. Extruded aluminum sign panels and edge strip shall conform to B 221, alloy 6063 T6.

D. Hardware. Hardware shall be clear anodized, conforming to one of the following: B 209, alloy 2024 T4; B 211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6 or 2017 T4.

PART 3 EXECUTION

3.1 MODIFYING SIGNS WITH DEMOUNTABLE COPY

A. Existing copy or shields shall be carefully removed. The sign background material shall be thoroughly cleaned using mild detergent and water. New copy shall be installed as specified in the Contract Documents.

B. When specified in the Contract Documents, existing demountable copy shall be covered with sheet aluminum having a minimum thickness of four hundredths of an inch (0.040″). The overlay shall contain the sign background and copy.

3.2 MODIFYING SIGNS WITH DIRECT APPLIED COPY

A. When specified in the Contract Documents, existing copy shall be covered with sheet aluminum having a minimum thickness of four hundredths of an inch (0.040″). The overlay shall contain the sign background and copy.

B. The Contractor may use direct applied overlays for minor modifications to sign messages in conformance with the manufacturer's recommendation.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all cleaning, material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Modify Message on Existing Ground Mounted or Overhead Signs will be measured and paid for at the Contract Unit Price per each removed or each installed character for the type of sign installation specified. Characters include shields, arrows and sign copy.

C. Overlay Existing Ground Mounted or Overhead Signs will be measured and paid for at the Contract Unit Price per square foot, removed or installed for the type of sign specified.

10 14 53.23 TEMPORARY TRAFFIC SIGNS (TTS)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing and installing Temporary Traffic Signs on or along any transportation facility as specified in the Contract Documents.

B. The Contractor shall maintain sign faces free of tape, tape residue or any other foreign matter and shall remove any advertisements from signs and supports. Supplemental signs shall not cover any part of the face of the primary sign.

PART 2 PRODUCTS

2.1 MATERIALS

A. Wood Sign Supports. Refer to 10 14 15.05, (Wood Sign Supports)

B. Reflectorization. Refer to 10 14 53, (Signs)

C. Signs. Refer to 10 14 53, (Signs)

D. Portable Sign Supports, Composite Aluminum Signs, Plastic Signs and Flexible Roll Up Signs shall be as approved by the Engineer.

PART 3 EXECUTION

3.1 CONSTRUCTION

A. Temporary Traffic Signs shall be as specified in the Contract Documents or as directed by the Engineer.

B. The signing shall conform to MUTCD or the Maryland State Highway Administration's Standard Highway Sign Booklet (SHSB). All Work area warning signs shall be forty-eight inches by forty-eight inches (48″ X 48″) unless otherwise specified. The SHSB may be obtained from the Maryland State Highway Administration's Office of Traffic and Safety, Traffic Engineering Design Division. Designs of signs not included in the SHSB may be prepared by the Contractor in sketch form, to scale, and approved by the Engineer.

C. Signs that will be in place for more than three (3) working days shall be mounted on two (2), four inch by four inch (4″ X 4″) wood posts unless otherwise specified. The height of the sign shall be as specified in the Contract Documents. Additional bracing of signs is prohibited. The tops of the wood posts shall not protrude more than three inches (3″) beyond the nearest edge of the sign. Wood posts four inches by four inches (4″ X 4″) shall be placed a minimum of four feet (4′) into the ground. Wood posts four inches by six inches (4″ X 6″) shall be placed a minimum of five feet (5′) into the ground.

D. Signs on portable supports for temporary conditions shall be mounted so that the bottom of the sign shall not be less than one foot (1′) above the roadway pavement elevation. Portable sign supports shall be self-erecting, able to withstand a wind velocity of seventy (70) mph and shall be able to maintain themselves within five degrees (5°) rotation around their vertical axis.

E. Fabricated aluminum signs to be mounted on wood posts shall have the following minimum thickness.

LONGEST DIMENSION OF SIGN inches	**MINIMUM THICKNESS inches**
≤ 12	0.040
12+ to 24	0.063
24+ to 36	0.080
36+ to 48	0.10
> 48	0.125

F. Composite aluminum, plastic, or flexible roll up signs shall only be used on those portable supports that are approved to hold that sign material by the Engineer. The minimum thickness of composite aluminum signs, supported on portable sign supports, shall be eight-hundredths (0.08) inches.

G. Temporary Traffic Signs shall not be installed until inspected and approved by the Engineer. The signs shall not be displayed to traffic until directed by the Engineer. Temporary Traffic Signs shall be properly maintained, remain in place only as needed and be immediately removed thereafter. Where operations are performed in phases or stages, only those signs that apply to the present conditions shall be displayed to traffic.

H. Special care shall be exercised to properly space signs along the highway to ensure that traffic is provided adequate sight distance to both work zone signs and existing signs. When a sign is not indicative of actual conditions such as during periods of temporary shutdown or extended periods of no Work being performed (including lunchtimes and overnight periods), the Contractor shall remove the entire work zone setup and remove the sign, turn it away from all traffic (turning parallel to traffic is prohibited), or completely cover it with an opaque material that is approved by the Engineer. This will not be required for non-work periods of time up to one (1) hour.

I. Signs shall not be obscured by weeds, shrubs, trees, construction equipment, materials, waste materials, personal vehicles, or any other obstruction and shall conform to the sight distance requirements as specified in the Contract Documents.

J. Temporary Traffic Signs for both daytime and nighttime use shall be reflectorized.

K. Sign Replacement. Signs shall be new or in like new condition. Signs that become faded, illegible or damaged shall be replaced as directed by the Engineer. Signs damaged due to the Contractor's operations shall be replaced at no additional cost to the City. Signs that are not new will be permitted to be used only if their reflective intensity at a divergence angle of two tenths degree (0.2°) and incidence angle of minus four degrees (−4°) conforms to at least seventy percent (70%) of the values specified in 10 14 53, (Signs). At other times throughout the duration of the Contract, the sign reflectivity intensity shall be a minimum of sixty percent (60%). The acceptability of the signs shall be measured by means of sixty percent (60%) and seventy percent (70%) calibrated one (1) foot square test plates at the appropriate times. The test plates shall conform to these requirements.

PART 4 MEASUREMENT AND PAYMENT

A. Temporary traffic signs will be measured and paid for at the Contract Unit Price per square foot for the pertinent Temporary Traffic Sign item. The payment will be full compensation for furnishing the signs and supports, wood posts, erection, relocation, maintenance, cleaning, replacement due to non-traffic damage or normal wear, removal and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Where signs have been set and are subsequently damaged by traffic and the Engineer determines that they are not repairable, they shall be replaced and will be measured and paid for at the Contract Unit Price.

C. Temporary traffic signs and all associated hardware, fittings, posts, brackets and incidentals shall be removed from the project site when no longer needed and become the property of the Contractor.

10 14 53.33 MODIFICATION OF EXISTING SIGNS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of relocating, removing, covering, modifying, re-erecting or changing existing highway signs relating to the construction activity. This Work is in addition to the temporary traffic signs specified in 10 14 53.23, (Temporary Traffic Signs (TTS).

PART 2 PRODUCTS

2.1 MATERIAL

Not applicable.

PART 3 EXECUTION

Modification of existing signs shall be as specified in the Contract Documents or as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Modification of existing signs will be measured and paid for using one (1) or more of the items below and specified in the Contract Documents. The payment will be full compensation for all excavation, backfill, hardware, relocation, removal, covering, modifying, re-erecting, changes to existing highway signs, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

1. Relocate Wood Sign Supports per each support.
2. Sign Modifications to Overhead Sign Structures per square foot.
3. Relocate Sign per square foot.
4. Remove Sign per square foot.
5. Modify Copy per each character.
6. Install or Remove Shield per each.
7. Cover Sign per square foot.
8. Relocate Sign Luminaries per each.

10 14 63.11 PORTABLE VARIABLE MESSAGE SIGNS (PVMS)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing portable, self-contained, trailer mounted, variable message signs as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Each unit shall contain the trailer, structural support system, sign panel assembly, lift mechanism, power supplies, sign mounted controller and ancillary equipment.

B. All materials for PVMS shall be new, corrosion resistant, unaffected by water spray, salt, oil, gasoline and all other contaminants in the quantities normally found along the edge of the traveled roadway. The PVMS construction, materials and operation shall conform to the NFPA, UL and NEC. All sign messages shall be visible and legible for a distance of nine hundred feet (900') from any point along the approached traveled roadway during twenty-four (24) hour operations. The PVMS shall be equipped with a sighting device to provide alignment for maximum visibility.

PART 3 EXECUTION

3.1 Equipment

A. Trailer. The trailer shall conform to Maryland Motor Vehicle Law governing trailers.

B. Structural Support. The structural support framework shall allow the system to be assembled into a unit and be mounted on the trailer and shall provide the support mechanism between the sign panel assembly, the power supply, and the controller. The framework shall provide sufficient support to prevent damage to any PVMS components when the sign is in down and locked position during normal highway travel. The deployed structure shall supply adequate support to allow complete sign operation, including the rising and lowering of the sign panel, during maximum sustained wind speeds of eighty-five (85) mph. The display windows shall be made of impact-resistant clear Lexan or as approved by the Engineer.

C. Sign Panel.

1. Sign panel dimensions shall not exceed a one hundred forty-four inches (144″) in length, ninety inches (90″) in height and twelve inches (12″) in depth.
2. The PVMS shall be capable of displaying three (3) lines of text.

    a. Each line of text shall be constructed using a continuous or discrete matrix display.
    b. The sign shall be capable of displaying eight (8) characters per line.
    c. The character height shall be a minimum of eighteen inches (18″).
    d. If discrete matrix display is used, each character shall be displayed using a five by seven inches (5″ X 7″) array with a minimum of eight (8) array modules per line.
    e. If discrete matrix display is used, a four and one-quarter inch to seven inch (4-1/4″ to 7″) space shall exist between each display line with no glare reflection. If full matrix display is used, the sign shall have at least twenty (25) rows and forty-five (45) columns of disks. If continuous line matrix display is used, the sign shall have at least 7 rows and 45 columns of disks and a 4 1/4 to 7 inch space shall exist between each display line with no glare reflection.

3. Flip Disk Mechanism shall have the following characteristics:

   a. Be electromagnetically activated (flipped), with a minimum service life of two hundred million (200,000,000) operations.
   b. Have a reflective surface that will maintain its color intensity for a minimum of three (3) years.
   c. Be circular or rectangular in shape with a visible surface area between three and three-quarter and four and one-quarter square inches (3-3/4 and 4 1/4 in^2).
   d. When flip-disk technology is used, each sign shall have fluorescent light bulbs placed above and below each line for a total of four (4) light bulbs to provide a continuous and uniform illumination pattern for nighttime visibility.

4. LED Illumination for each matrix element shall have the following characteristics:

   a. LED shall conform to the ITE Specification for amber color.
   b. LED shall utilize A1 in gap substrate.
   c. Each LED shall produce a minimum of one (1) candela output on center at twenty five (25) ma drive current.
   d. Each matrix element shall have a minimum of (2) LED's located within the perimeter of the flipping disk.
   e. LED shall provide full illumination within a minimum of twenty-four (24) cone perpendicular to the sign face.
   f. Operating temperature range of the LED shall be −40° to 160° F.

D. PVMS UNIT: The Contractor shall submit a catalog cut sheet and a character set for any PVMS for approval to the Engineer.

1. Lift Mechanism.

   a. The lift mechanism shall be an electric or electrically assisted hydraulic mechanism capable of raising and lowering the sign panel.
   b. The mechanism shall be capable of being raised and lowered manually.
   c. A stainless steel safety bolt shall be provided to prevent the sign panel from lowering once in the raised position. A self-locking mechanism shall be incorporated into the safety bolt which prevents it from being inadvertently dislodged.
   d. The lift mechanism shall allow the raised sign panel to rotate three hundred sixty degrees (360°) about the vertical axis.
   e. Rotation shall be possible in either a clockwise or counter-clockwise direction.
   f. A locking mechanism shall be provided to prevent rotation of the sign panel assembly once the sign panel is in place, at any position.

E. Electrical Connections and Gauges.

1. All wiring from power sources to PVMS equipment shall use locking cable connectors.
2. Volt and amp gauges shall be provided for both AC and DC.
3. Standard negative ground system shall be tied to the sign chassis.

4. Lightning protection shall be supplied to the load side of the sign system's distributed power lines to withstand multiple surges in excess of six hundred (600) volts.

F. Power Supply: The PVMS shall operate from either a solar powered electrical system, an existing commercial electrical service or a diesel powered generator.

G. Solar Powered Electrical System: This system shall have a battery powered system and solar array panels and be capable of displaying two (2) page messages for twenty-one (21) consecutive days without auxiliary charge.

H. Sign Controller: The controller shall:

1. Be capable of driving the matrix display panel operating over a range of minus fifty degrees to one hundred fifty degrees (−50° to 150°) F and in a twenty percent to one hundred percent (20% to 100%) non-condensing humidity range.
2. Accommodate one hundred (100) preprogrammed, user-defined messages.
3. Be capable of displaying three (3) sequenced messages. On/Off time for each message in a sequence shall be user adjustable within a range of zero to five (0 to 5) seconds.
4. Be designed for fail-safe prevention of improper information display in the case of a system malfunction.
5. Cause a user defined default message to be displayed in case of failure of the PVMS unit when flip disk mechanism is used.
6. Have the capability of retrieving all messages stored in temporary memory.

    a. Temporary memory shall be nonvolatile.
    b. All messages and programs shall remain resident in the controller's memory in the event of a power failure.
    c. Have an RS-232 port to facilitate connection of an external communication device.

7. Be capable of automatic system recovery after power outages to the central controller without operator intervention, including the ability to maintain an up-to-date status on a remote unit if sign is operated from a remote location.
8. Monitor and display the battery output voltage and solar array activities (charging/discharging). The controller shall blank the sign when the battery output voltage drops below the manufacturer's recommended output level.
9. Be capable of monitoring and displaying the status of the photocell and adjust the sign illumination to match the ambient light conditions. The controller shall have a minimum of nine (9) levels of dimming from ten percent to one hundred percent (10% to 100%) brightness.
10. Be contained in a sheet metal, weatherproof cabinet located on the controller housing, and insulated to protect against excessive vibration and temperature.

    a. The cabinet shall have a lockable door latch and interior cabinet dome light.
    b. A keyboard storage location shall be provided inside the cabinet.

I. Character Set Software. The character set software shall:

1. Have all of the standard ASCII characters and symbols.
2. Left and right arrows shall be provided.

3. Have all alphanumeric entries performed with a keyboard that utilizes a standard QWERTY style layout.
4. The corresponding character on the keyboard shall cause the same character to be displayed on the matrix. Arrow symbols shall be generated via a cursor pad on the keyboard.
5. Have messages default to self-centering display with the ability to left or right justify a display when continuous matrix is used.

3.2 GENERAL

A. The PVMS shall be on the project site and operated twenty-four (24) hours in advance of actual use to ensure that each unit is functioning properly and approved by the Engineer. The PVMS shall be installed as specified in the Contract Documents or as directed by the Engineer.

B. The PVMS shall be aimed at approaching traffic to ensure that it conforms to the 900 ft minimum legibility distance and that the sign face is not obscured by highway alignment or glare from either sunlight or vehicle headlights. The PVMS shall be level.

PART 4 MEASUREMENT AND PAYMENT

A. The Portable Variable Message Sign will be measured and paid for at the Contract Price per unit day. A unit day shall consist of any approved usage within a twenty-four (24) hour day period. Each Portable Variable Message Sign will be paid for only once per unit day, regardless of how many times it is relocated. When a unit is used for part of a day, it will be measured as a unit day. This unit price will be the same regardless of the type of unit used.

B. The payment will be full compensation for the installation, sign, diesel generator, all fuel and refueling, electrical power and hook up, setup and maintenance of computer programs, changing messages, relocating as required by the Traffic Control Plan or as directed by the Engineer, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

10 14 63.12 ARROW PANEL (AP)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing and placing Arrow Panels for temporary use. Arrow Panels shall supplement, but not replace, standard signing as specified in the Contract Documents.

B. AP's shall be self-contained, vehicle mounted or portable and shall be approved by the Engineer. Self-contained trailer units shall be used unless otherwise specified in the Contract Documents.

C. AP's shall have both manual and automatic dimmer devices. These devices shall be capable of reducing the light intensity by fifty percent (50%). Photocells for the automatic dimmers shall be periodically cleaned to prevent malfunctioning of the brightness control.

D. The use of dimmer devices shall be mandatory during the night operation of any AP's. Manual and automatic dimmer devices shall be designed to include a fail safe system which shall ensure that maximum brightness is displayed during sunlight and fifty percent (50%) brightness is displayed during darkness, regardless of which dimmer device is operational.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. The Contractor shall furnish and test the AP's as directed by the Engineer twenty-four (24) hours in advance of actual use to ensure that the units are functioning properly. The AP unit shall conform to the Arrow Panel table and shall be arranged with double pointed arrow configuration capable of displaying a left arrow, right arrow, double arrow, and a four (4) corner caution mode. Sequential chevron display is also acceptable if all operational modes can be displayed.

ARROW PANEL				
AP UNIT	MUTCD TYPE	LAMP OPTIONS*		
		No. 4412 A-Par 46	No. 4415A	1295 GE
Portable	A	—	X	X
Vehicle Mounted	B	X	—	—
Self-Contained Trailer	C	X	—	—
Portable	D	—	X	X

*Or as approved by the Engineer.

B. AP's shall be used to close any lanes of a multilane highway. AP's shall be placed as directed by the Engineer. The Contractor shall maintain all AP's in good operating order.

1. AP's shall conform to the applicable requirements of the MUTCD. AP's shall only be used to supplement other required traffic control devices. AP's shall be used in the "Arrow" mode only when closing a through travel lane on a multilane roadway. Only one (1) AP in the "Arrow" mode shall be used for each stationary lane closure. Moving Work operations may utilize one or more AP's for a single lane closure. Care shall be taken in the placement of AP's to avoid driver confusion in the vicinity of ramps, median crossovers and side road intersections.
2. AP's shall be aimed at approaching traffic in conformance with the minimum legibility distance specified in the MUTCD. AP's shall be erected so that the arrow is level in relation to the roadway.
3. For stationary lane closures, the AP shall be placed on the shoulder at the beginning of the taper (nearest to oncoming traffic) or, where there are narrow or no existing shoulders in the closed lane behind the channelizing devices, as near to the beginning of the taper as possible.

4. For moving maintenance type activities along multilane highways where a lane is closed, the AP shall be placed at the rear of the activity in the closed lane on a vehicle separate from the maintenance vehicle itself. For paint striping activities, additional vehicles with AP's in the arrow mode may be required to supplement this Work operation. AP's shall always remain upstream of the maintenance vehicle where adequate recognition distance is available. The vehicle carrying the AP shall also be equipped with signing and lighting as required by the standard Traffic Control Plans.
5. AP's shall only display the "Caution" mode for a lane closure on a two (2) lane, two (2) way roadway or for a shoulder closure on any roadway. The "Caution" mode on an AP shall show only one (1) light in each corner of the AP.

PART 4 MEASUREMENT AND PAYMENT

A. Arrow Panels will be measured and paid for at the Contract Price per unit day. A unit day shall consist of any approved usage within a twenty-four (24) hour calendar day period. Each Arrow Panel will be paid for only once per unit day, regardless of how many times it is relocated. When an arrow panel is used for part of a day, it will be measured and paid for as a unit day.

B. The payment will be full compensation for all material, labor, equipment, tools, incidentals required to set up and operate at the site as required and at any relocated site as required by the Traffic Control Plan or as directed by the Engineer.

DIVISION 13
SPECIAL CONSTRUCTION
13 22 00 SPECIAL PURPOSE ROOMS

13 22 00 ENGINEER'S OFFICE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, cleaning and maintaining in good condition an Engineer's office at a location within the immediate vicinity of the project and approved by the Engineer. The Engineer's office shall be separated from any offices used by the Contractor and it and all items therein shall be for the exclusive use of the City's Engineers and Inspectors. Rented properties that conform to the type of office specified in the Contract Documents will be acceptable.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 GENERAL

A. The office shall be set up, equipped and made ready for use a minimum of five (5) days prior to commencement of other Work on the project and shall remain until all field records have been completed. Upon removal, the location shall be restored and left in a condition acceptable to the Engineer.

B. Unless otherwise specified, the Engineer's office and all equipment and accessories furnished by the Contractor shall become the property of the Contractor at the completion of the project.

3.2 MOBILE HOUSING UNIT

A. The Contractor shall provide a mobile housing unit having a minimum floor space of sixty feet square (60′) and a minimum window area of ten feet square (10′) to provide natural light. It shall be entirely enclosed, waterproofed and have a door that locks. It shall be equipped with at least one (1) table thirty-six inches by forty-eight inches by forty inches (36″ X 48″ X 40″) high and one (1) closet equipped with lock for storing equipment. Two (2) keys for each lock shall be provided to the Engineer. Satisfactory heating and cooling shall be provided.

B. In some cases Contract Documents bid items will allot a space for the Engineer's office, however when the Contract Documents do not designate an area, it is understood that the Contractor will provide space for the Engineer's office and laydown areas.

3.3 HANDICAP ACCESSIBILITY

When handicap accessibility is necessary, it shall comply with the Federal Americans with Disability Act (ADA) Accessibility Guidelines for Buildings and Facilities.

3.4 MOBILE OFFICE TRAILERS

Office trailers shall be anchored in conformance with the manufacturer's recommendations. Office trailers defined under the Industrial Building and Mobile Act of Maryland shall be approved by the Maryland Department of Housing and Community Development and bear the Maryland Certification Insignia. The Insignia shall be located in the interior of the office.

3.5 CONSTRUCTION REQUIREMENTS FOR ALL OFFICES

A. Entirely enclosed, waterproofed and completely insulated to a minimum R11 rating.

B. Double thick floor with building paper placed on top of the lower floor.

C. Finished inside and outside as approved by the Engineer.

D. The building shall have a minimum ceiling height of seven feet (7′) and have a pitched roof with a ventilating louver in each gable.

E. A four foot by one foot (4′ X 1′) minimum sign with the message "ENGINEER'S OFFICE – BALTIMORE CITY" shall be attached to or mounted in front of the office. The sign shall have a black background with minimum three inch (3″) height white lettering. It shall have a one inch (1″) wide white border around the entire sign.

F. A five inch by seven inch (5″ X 7″) minimum no smoking sign shall be posted on the outside of each entrance to the office, plant laboratory and mobile housing unit.

G. Interior and exterior doors shall be equipped with different key locks. Interior doors shall be keyed alike and exterior doors shall be keyed alike. Exterior doors shall have an additional dead bolt lock. The Contractor shall provide the Engineer four (4) keys for the interior and exterior locks.

H. Windows shall be capable of being opened and closed and be equipped with latches and screens. Each window shall have venetian blinds or shades.

I. Electrical service shall conform to national and State electrical codes with satisfactory artificial lighting and lighting services. The minimum illumination level shall be seventy-five (75) foot-candles.

J. Equipment shall be provided to enable heating the office to at least seventy degrees (70°) F and cooling to at least seventy-eight degrees (78°) F.

K. The restroom facility shall include washbasin, water closet, soap holder, paper towel holder and mirror. It shall be connected to water and sewage or a well and septic system. A pressurized water system capable of maintaining a minimum pressure of twenty (20) psi

shall be provided. These facilities shall conform to the State Department of Health and Mental Hygiene or other authorities having jurisdiction.

L. The Contractor shall maintain the Engineer's facilities in a clean and sanitary condition and have the trash removed daily. Floors shall be swept daily and damp mopped and waxed biweekly. The interior and exterior of all windows shall be cleaned monthly. Additionally, this Work shall be performed on an as needed basis when requested by the Engineer.

M. Fire extinguishers shall be dry chemical, multi-purpose ABC type (minimum ten (10) lb), equipped with a visual air pressure gauge. They shall be maintained in conformance with OSHA safety and health standards.

N. A twenty-four (24) unit first aid kit shall be furnished and maintained as described in the Federal Regulations.

O. A waterproof bulletin board, minimum four feet by eight feet (4′ X 8′), shall be installed within the limits of the project in an easily accessible area and shall be conspicuously displayed to all employees. The Contractor shall post all pertinent and required notices and shall maintain it for the duration of the project.

P. Touch-tone telephones equipped with an answering device capable of answering, recording, storing and playing back messages at least thirty (30) minutes in length. The machine shall be voice activated, beeperless, to record as long as the speaker speaks and shall play back recorded messages without dial tone or pauses. The machine shall be capable of recording outgoing messages up to fifteen (15) seconds in length.

1. If a telephone or answering machine becomes defective, is stolen, or for any other reason does not function as intended, it shall be replaced with an equal or better unit within eight hours after the Contractor is notified at no additional cost to the City.
2. Emergency telephone numbers shall be conspicuously posted in the office.

Q. One (1), twelve (12) cu.ft. electric refrigerator shall be provided.

R. One (1) modern cassette player/recorder with cassettes and approved by the Engineer shall be provided.

S. One (1) modern one-step operation paper copier machine shall be provided. The Contractor shall supply paper and provide service as needed.

T. One (1) sanitary type electric water cooler including bottled water and disposable cups shall be provided.

3.6 MICROCOMPUTER SYSTEM FOR ALL OFFICES

A. Desktop Unit compatible with software being used on the project.

B. Internet Access: The microcomputer system shall be provided with unlimited Internet access approved by the Engineer.

C. Accessories.

1. Uninterruptible power supply (UPS).
2. Standard computer workstation.

3. Eight and one-half inches by eleven inches (8-1/2″ X 11″) xerographic paper to be supplied as needed.
4. Toner or ink as needed for printer.
5. Maintenance agreement to provide for possible down time.
6. Physical security system to deter theft of computer components.

D. Notes.

1. The microcomputer system shall be completely set up ready for use on or before the day the Engineer's office is to be occupied.
2. All software shall be supplied on original disks with original manuals and be retained in the construction field office for the duration of the Contract.
3. If for any reason the system fails to operate, the system shall be replaced or repaired within forty-eight (48) hours.
4. When the microcomputer system is no longer required, the Construction Management software system including original user/operator guide manuals, program disks and all data files will be removed by the Engineer and become the property of the City. The remaining microcomputer system shall remain the property of the Contractor.

3.7 FACSIMILE (FAX) TRANSCEIVER FOR ALL OFFICES

A. Shall have separate independent telephone line and phone number to dedicated phone jack.

B. Shall have self-test capability, provide activity reports, and provide page headers, time and date.

C. Shall use standard copy paper for receiving transmissions.

3.8 SPECIFIC FIELD OFFICE REQUIREMENTS

A. Type 1 Engineer's Office — Standard office trailer see end of Document.

B. Type 2 Engineer's Office — Standard office trailer see end of Document.

C. Type 3 Engineer's Office — Standard office trailer see end of Document.

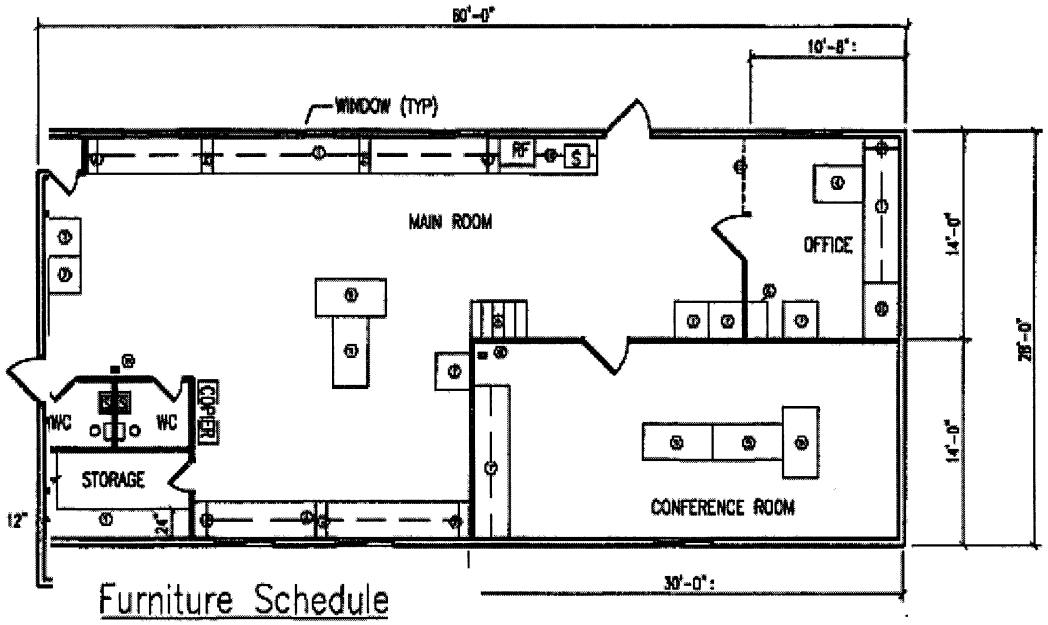
PART 4 MEASUREMENT AND PAYMENT

A. Engineer's office will not be measured but will be paid for at the Contract lump sum price for the pertinent Engineer's Office specified in the Contract Documents.

B. Payment of fifty percent (50%) of the Contract lump sum price will be payable on the first estimate subsequent to complete installation of the Engineer's office. The remaining fifty percent (50%) will be prorated and paid in equal amounts on each subsequent monthly estimate. The number of months used for prorating will be the number estimated to complete the Work. The final month's prorated amount will not be paid until the office is removed and the area is restored. The payment will be full compensation for site preparation, utility costs, all specified furnishings, to provide equipment, clean, maintain, insure, remove and dispose of the office, restore the site and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

C. The only exception to the all inclusive Contract lump sum price is the stabilization of the parking area, which will be measured and paid for using the pertinent items as directed by the Engineer.

TRAILER 1



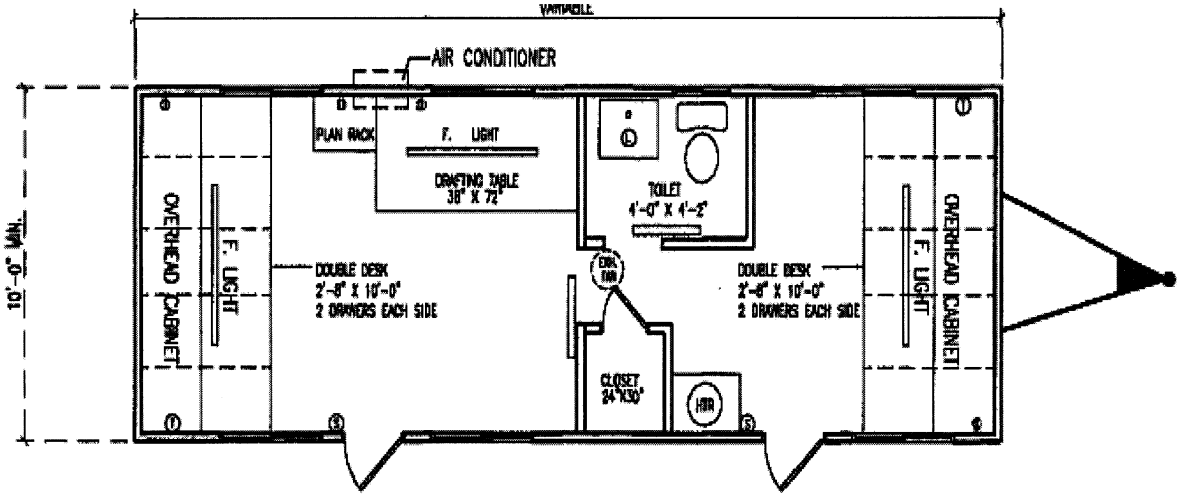
Furniture Schedule

1. COUNTER TOP WITH ABOVE WALL CABINETS
2. (2) DRAWER FILE (TYP.)
3-30" HIGH BASE CABINETS WITH TOP
4-DESK
5-30"X60" FOLDING TABLE
6-FILE CABINET
7-DRAWING RACK
8-WATER JUG
9-(5)SHELVES
10-BASE CABINET WITH TOP
11-DRAWING BOARD
12-3"X6' TAG BOARD
13-COAT ROD

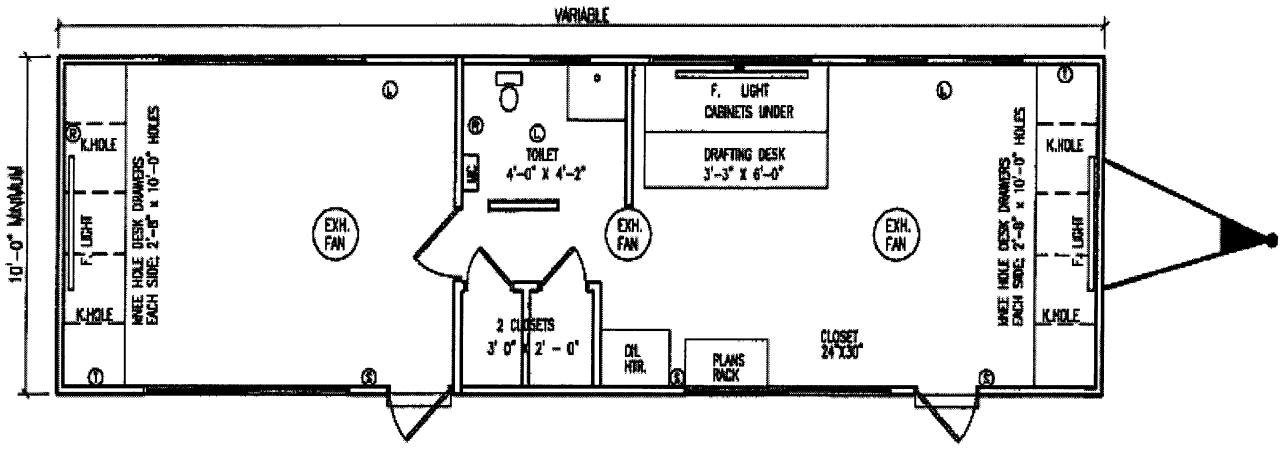
F-REFRIGATOR
-SINK
C-WATER CLOSET

PROVIDE 12" WIDE SHELF ABOVE EACH WC
(min. length,3')

TRAILER 2



TRAILER 3



Notes:

1. In addition to the equipment indicated above, air conditioning will be required. The cost of which is to be included in the Lump Sum Bid Price of the office. The system must be capable of maintaining a temperature of eighty degrees (80°) F dry bulb and approximately fifty percent (50%) relative humidity in the conditioned area when outside temperatures are ninety-five degrees (95°) F dry bulb and seventy-eight degrees (78°) F wet bulb. At least one (1) unit will be required for each of the two (2) compartments.
2. Furniture and fixtures indicated are basic to the trailer, additional equipment required and not shown include minimum two (2) exterior doors for egress, three (3) chairs, one (1) stool, one (1) drafting table, or drafting desk, and one (1) printing calculator.
3. Dimensions for the length may be varied so that when multiplied by the width a minimum required square footage.
4. The requirements for the trailer may be modified by the Engineer.
5. Furnishings, fixtures, and equipment must have the approval of the Engineer prior to installation.

13 34 00 FABRICATED ENGINEERED STRUCTURES

13 34 12 GENERAL MECHANICAL REQUIREMENTS FOR FACILITIES PROJECTS

PART 1 GENERAL

1.1 DESCRIPTION

A. The provisions of this section of the Specifications are intended to govern the quality of design, fabrication, workmanship, operation, etc., of all materials, equipment and appurtenances to be furnished and installed under the various sections that include mechanical equipment as part of the specified items.

B. Shop drawings, including dimensioned drawings, descriptive literature, performance data, electrical characteristics and in general, all information necessary to prove compliance with the Specifications, shall be submitted as required in 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).

C. The Contractor shall provide manufacturer's operation and maintenance manuals in accordance with 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data) as required in the Specifications.

D. Where standards, codes or specifications are referred to, the reference is to particular standards, codes or specifications together with all the latest amendments and errata applicable at the time that the bids are taken. These are listed as follows.

IEEE	Institute of Electrical & Electronics Engineers
AMCA	Air Moving and Conditioning Association, Inc.
ASTM	American Society of Testing and Materials
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers
AWS	American Welding Society
AWWA	American Water Works Association
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturer's Association
Federal	Federal Government Specifications
OSHA	Occupational Safety and Health Act

E. All equipment and machinery furnished under Contract shall be of the latest and most improved design suitable for the service of which it is to be used. All equipment and machinery shall be designed and constructed to operate efficiently, continuously and quietly under the specified requirements with a minimum of labor, power, maintenance, renewals and repairs. The design and construction of all equipment and machinery shall be such as to permit operation with minimum noise, wear and vibration (maximum overall peak velocity of one-tenth inch (0.1″) per second (ips) unless otherwise specified) when properly installed.

F. Ample room for erecting, repairing, inspecting and adjusting all equipment and machinery shall be provided. The design, construction and installation of all equipment and machinery shall conform to and comply with the latest safety codes and regulations.

G. The design and construction of the several units shall be such that they shall present a uniform appearance and the arrangement shall be such that their operation shall be in harmony in every respect. Whenever possible, fittings and fixtures of the same make and model shall be used for several units and their connections. All equipment of identical type and service shall be the product of the same manufacturer.

H. All equipment selected shall be of such size and general arrangement to suit the space in which it is to be installed.

I. The various parts of the equipment and machinery shall be of plain shape and good lines, especially designed and constructed for strength and durability. Casting shall be design

and constructed to cool uniformly without shrinking strains and shall have good-sized fillets at all re-entrant corners. Sudden change of section shall be avoided.

J. Whenever possible, parts of each unit shall be made to gauge, be a duplicate of and be interchangeable with the same parts of other machines of the same size and kind.

K. The workmanship shall be of the highest quality throughout.

L. All assemblies shall be completely shop fabricated and structural steel parts shall be shop erected. Assemblies and structural steel parts shall be matchmarked before being disassembled for shipment. Parts shall be shipped assembled in as large a unit as possible to minimize field reassembly. All parts shall be amply proportioned for all stresses, which may occur during operation, and for any additional stresses, which may occur during fabrication and erection.

M. Unless otherwise specified, welding shall be in accordance with the latest standard specifications for "Gas Tight Welding" of the American Welding Society.

N. Unless otherwise specified, galvanizing shall be hot-dipped, in accordance with the latest standard specifications for "Zinc Coating," ASTM A123.

O. The Contractor shall furnish manufacturer's certificates in accordance with submittals section of the Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

A. Unless otherwise specified, materials shall be in accordance with the latest standard specifications of ASTM:

Structural Steel	A-36
Welded Steel Pipe	A-53
Iron Castings	A-48
Babbitt	B-23
Bronze Castings	B-30
Bronze (Manganese)	B-138
Bronze (Silicone)	B-98
Steel Bolts	A-307
Hot Dip Zinc Coating	A-123

B. All materials shall, if required, be tested and shall fulfill all requirements specified. Physical tests may be made by the City. The Contractor, at its own expense, shall furnish test pieces and samples in the number, shape, size and finish required by the Engineer. All broken material shall become the property of the Contractor, unless requested in writing by the City. The failure of test specimens to fully conform to the requirements of the Specifications shall be sufficient cause for rejection of the whole melt or stock from which samples were obtained.

C. Iron castings shall be smooth, clean and free from scale, lumps, blisters and other defects. No plugging, welding or filling will be allowed except as noted in the Specifications.

D. The alloy grade number of all babbitt shall be that bearing alloy of a composition recommended by the manufacturer of the equipment or machinery for the service required, subject to the approval of the Engineer

E. All bronze shall be made of new material and shall be free from objectionable imperfections. If the materials show signs of improper mixing when being machined, the castings will be rejected.

F. Journals and bearing surfaces shall be of sufficient size and properly proportioned for the least wear and to avoid heating under all conditions and where necessary, provisions shall be made for easy removal and for proper adjustments. Journals shall be suitable boxes, which, where necessary, shall be lined with babbitt metal hammered into grooves and bored in place. If bearings are of the ball-bearing type, both inner and outer races as well as the balls shall be heat-treated steel to resist wear. The balls shall be of ample size to carry the maximum loads with a large factor of safety to prevent flaking, spalling or crushing. The balls shall be properly spaced and held in position by rugged continuous spacing or retainer rings.

G. Pins and keys shall be properly proportioned. Keys, nuts and all other parts, which might otherwise work loose, shall be secured with approved locking devices.

H. All bearings, except those specifically requiring oil or water lubrication, shall be pressure grease lubricated. All lubrication points shall be readily accessible, away from locations dangerous to workers. Pressure grease lubrication fittings shall be the "Alemite" type as made by the Stewart Warner Corporation or equal. The pattern of the fitting shall be selected for accessibility in lubricating and shall meet the approval of the Engineer. Housing of grease-lubricated bearings shall be automatically exhausted to atmosphere to prevent excessive greasing.

I. The Contractor shall furnish lubrication charts or schedules for each piece of equipment or machinery. The charts or schedules shall designate each point of lubrication, the type of lubricant to be applied and the frequency of lubrication. Charts and schedules shall be submitted to the Engineer in quadruplicate, bound in folios, with each chart or schedule protected by a transparent plastic envelope.

J. Motors and controls shall conform to the latest requirements of IEEE and NEMA, and where applicable, shall be UL listed. Minimum sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor, which is controlled, or in an electrical Specification section. The Contractor is advised to consult all Specification sections to determine responsibility for motors and controls.

K. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG-1.

L. Motors shall be suitable for use under the conditions and with the equipment to which applied and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no conditions shall the motor current exceed that indicated on the nameplate.

2. Motor sizes noted in the individual equipment Specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overload, without exceeding the rated full-load current or overheating at full-load capacity under the most severe operating service of this equipments.
3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.
4. Motors shall be designed for operation on SIXTY (60)-hertz power service. Unless otherwise specified or shown, motors less than one half (1/2) horsepower shall be single phase and motors one-half (1/2) horsepower and larger shall be three (3) phases.
5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

M. Flanges, except as otherwise specified, shall be cast solid and bolt holes shall have drilled and spot-faced on the back. Stud holes shall not be drilled through. Flanges shall be uniform in thickness and shall come fair and, if required, shall be turned or chipped in a neat and workmanlike manner.

N. Jacking screws shall be provided for covers, etc. where required and also suitable eye bolts for lifting. Bolts and nuts shall be of the best quality of open hearth, free machining steel. Bolts shall have good, sound well-fitting threads; nuts shall be cold pressed. All heads, nuts and threads shall be of American Standard regular sizes. All ferrous bolts and nuts shall be galvanized by the hot dipped process.

O. All equipment and motor/drives shall be field aligned using dial indicators and feeler gauges in accordance with the procedures established by the latest revision of the Hydraulic Institute Standards (ANSI/HI 1.4 or 3.4). Parallel and angular misalignment shall not exceed the limits recommended by both the equipment and the coupling manufacturer.

P. The various items of motor driven equipment, such as pumps, shall be mounted on structural steel bedplates. The bedplates shall be of adequate size to accommodate the equipment and its motor, to form an integral rigid mounting platform. Steel or brass shims shall be used to level equipment bedplates mounted in contact with concrete pads or floors. Jacking bolts or jacking (leveling) nuts on mounting studs shall not be used in lieu of shims. Bedplates shall be grouted to the concrete base and shall be filled with grout in all instances where the manufacturer has made provision for introducing grouting mixture into bedplate cavities. It shall be the Contractor's complete responsibility to determine the proper method, to provide all materials and components required, to coordinate the Work, and to set, couple, align and install all equipment in a satisfactory manner.

PART 3 EXECUTION

3.1 GENERAL

A. The general arrangement of pipe and equipment shall be as shown on the Drawings. Detailed drawings of proposed departures due to actual field conditions or other causes shall be submitted to the Engineer for approval. The Contractor shall carefully examine the Drawings and shall be responsible for the proper fitting of materials and equipment as indicated, without substantial alternation. Because of the small scale of the Drawings, it is

not possible to indicate the exact location of all piping, offsets, fittings and accessories, which may be required. The Contractor shall carefully investigate the space requirements for proper clearances and the structural and finish conditions affecting its work and shall arrange such work accordingly, finishing such offsets, fittings, valves and accessories as may be required to meet such conditions.

B. Each trade shall determine the location, size, etc. of all chases and openings required for the proper installation of its Work and shall see that such are provided. Where it is necessary to run pipes or ductwork through walls or fittings, the trade performing the Work shall notify the Contractor so that proper provisions can be made for same. Each trade shall furnish and set all inserts, sleeves, hanger supports, etc. required for its work and shall be responsible for their proper and permanent location.

C. All piping exposed to view shall be run generally parallel with the lines of the building and as close to walls and columns as may be practical and consistent with proper grade and the maintenance of proper clearances for access to all parts requiring servicing.

3.2 TESTING

A. After erection, the Contractor shall adjust and balance all equipment and systems and shall demonstrate that all equipment is operating in a satisfactory manner. All rotating equipment shall be lubricated according to recommendations of the manufacturer and all adjustments shall be made to suit anticipated station operating conditions. Each piece of machinery shall be tested to show that it operates quietly, without vibration, overheating or sign of distress at full specified capacity. Adjustments shall be made as necessary. All defective parts on machinery shall be replaced.

B. The Engineer shall be notified in advance of all tests and all tests shall be conducted to its entire satisfaction.

3.3 MISCELLANEOUS

A. Finished parts shall be well protected in the shop, during transportation and before and after erection to prevent injury of any kind. Injured parts which in the opinion of the Engineer are damaged or which cannot be refitted shall be promptly replaced by the Contractor without expense to the City. All exposed finished parts of machinery shall be greased or oiled before shipment.

B. All exposed belts, gears and drives shall be protected with guards. Guards may be of the equipment manufacturer's standard design, but must meet all OSHA Standards.

3.4 PAINTING AND LABELING

A. All fabricated or assembled surfaces normally painted shall be thoroughly dry and free from all rust, grease, dirt or scale. The Contractor is reminded to correlate the selection of shop prime coats to be compatible with subsequent field applied coats of paint. The Contractor shall touch up paint any item damaged during shipping or installation.

B. Each piece of equipment (including mechanical operators and electrical switches for the equipment) shall be identified by hand painting or stenciled, two inch (2″) letters and numbers, to indicate the service or function. Unless specified otherwise in the mechanical

and electrical sections of the Specifications, each motor and motor controller shall be similarly numbered (or lettered) to correspond to the number (or letter) of the driven unit.

3.5 ADJUSTMENTS TO RELATED WORK

The final Work shall include any adjustments that may be required by the approved equipment furnished, with modifications made to concrete shapes and to dimensions shown on the Contract Drawings as may be required to suit the details of the approved equipment furnished, all at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

General mechanical requirements will be paid as part of the Contract lump sum price.

DIVISION 23
HEATING, VENTILATING AND AIR CONDITIONING (HVAC)
23 05 00 COMMON WORK RESULTS FOR HVAC

23 05 93 HVAC TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Measuring sound and vibration.
7. Reporting results of the activities and procedures specified in this section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the sections that specify those systems and equipment.
2. Field quality control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment sections.

1.2 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of Work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

H. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

I. Test: A procedure to determine quantitative performance of a system or equipment.

J. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

K. AABC: Associated Air Balance Council.

L. AMCA: Air Movement and Control Association.

M. NEBB: National Environmental Balancing Bureau.

N. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.3 SUBMITTALS

A. Quality Assurance Submittals: Within thirty (30) days from the Contractor's Notice to Proceed, submit two (2) copies of evidence that the testing, adjusting, and balancing agent and this project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" article below.

B. Contract Documents Examination Report: Within forty-five (45) days from the Contractor's Notice to Proceed, submit two (2) copies of the Contract Documents review report as specified in Part 3 of this section.

C. Strategies and Procedures Plan: Within sixty (60) days from the Contractor's Notice to Proceed, submit two (2) copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" article below. Include a complete set of report forms intended for use on the project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit two (2) copies of reports prepared, as specified in this section, on approved forms certified by the testing, adjusting, and balancing agent.

E. Sample Report Forms: Submit two (2) sets of sample testing, adjusting, and balancing report forms.

F. Warranty: Submit two (2) copies of special warranty specified in the "Warranty" article below.

1.4 REQUIREMENTS

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Testing, Adjusting, and Balancing Conference: Meet with the City's representative and the architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing; adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls installer, and other support personnel. Provide seven (7) days' advance notice of scheduled meeting time and location to the Engineer.

1. Agenda Items: Include at least the following:

   a. Submittal distribution requirements.
   b. Contract Documents examination report.
   c. Testing, adjusting, and balancing plan.
   d. Work schedule and project site access requirements.
   e. Coordination and cooperation of trades and Subcontractors.
   f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or from SMACNA's "HVAC Systems Testing, Adjusting, and Balancing".

E. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Engineer.

F. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

G. Instrumentation Calibration: Calibrate instruments at least every six (6) months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS

Partial Owner Occupancy: The owner may occupy completed areas of the building before substantial completion. Cooperate with the owner during testing, adjusting, and balancing operations to minimize conflicts with the owner's operations.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide seven (7) days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. General Warranty: The national project performance guarantee specified in this article shall not deprive the City of other rights the City may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms or NEBB forms stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents described in "Project Record Documents".

D. Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine air handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine strainers for clean screens and proper perforations.

L. Examine heat transfer coils for correct piping connections and for clean and straight fins.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine automatic temperature system components to verify the following:

1. Dampers and other controlled devices operate by the intended controller.
2. Dampers are in the position indicated by the controller.
3. Integrity of dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.

7. Controller set points are set at design values. Observe and record system reactions to changes in conditions.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs according to design values.
10. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepares system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Ceilings are installed in critical areas where air pattern adjustments are required and access to balancing devices is provided.
6. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems—Testing, Adjusting, and Balancing" and this section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.

E. Locate start/stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air handling unit components.

3.5 CONSTANT VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this article apply to constant-volume supply, return, and exhaust air systems. Additional procedures are required for variable air volume, multizone, dual duct, induction unit supply air systems and process exhaust air systems. These additional procedures are specified in other articles in this section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air handling unit component.

    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Adjust fan speed higher or lower than design with the approval of the Engineer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan speed changes.
6. Do not make fan speed adjustments that result in motor overload. Consult equipment manufacturers about fan speed safety factors. Modulate dampers and measure fan motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

    a. Where sufficient space in submains and branch ducts is unavailable for pitot tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments. Measure terminal outlets using a direct reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

F. Determine total airflow into the room where the fume hood is located and balance systems to ensure adequate air supply to all hoods.

1. Set fume hood door opening at position of normal use.
2. Energize the exhaust fan and adjust airflow to provide the indicated average fume hood face velocity at hood opening.
3. Measure exhausts airflow volume by measuring airflow by pitot tube duct traverse.
4. Measure air velocity using pitot tube traverse method.
5. Record each face velocity measurement taken at four-inch to six-inch (4″ to 6″) increments over the entire hood door opening.
7. Calculate the airflow volume of exhaust hood face velocity by multiplying the calculated average face velocity by the opening area. Compare this quantity with exhaust volume at exhaust fan and report duct leakage.
8. Measure airflow volume supplied by makeup fan. Verify that the makeup system supplies the proper amount of air to keep the space at the indicated pressure with the exhaust systems in all operating conditions.

9. Retest for average face velocity. Adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity and the indicated auxiliary air supply percentages.
10. Retest and adjust the systems until fume hood performance complies with Contract Documents.

3.6 TEMPERATURE CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high and low temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Verify main control supply air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail safe operations.

3.7 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus five percent (+5%) to plus ten percent (+10%).
2. Air Outlets and Inlets: Zero (0) to minus ten percent (−10%).
3. Heating Water Flow Rate: Zero (0) to minus ten percent (−10%).
4. Cooling Water Flow Rate: Zero (0) to minus five percent (−5%).

3.8 REPORTING

A. Initial Construction Phase Report: Based on examination of the Contract Documents as specified in "Examination" article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes

and additions to HVAC systems and general Construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

A. General: Typewritten, or computer printout in letter quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing Engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include approved shop drawings and product data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing, adjusting, and balancing agent.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing agent who certifies the report.
10 Summary of contents, including the following:

a. Design versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size, and fittings.
13. Notes to explain why certain final data in the body of reports vary from design values.
14. Test conditions for fans and pump performance forms, including the following:

a. Settings for outside, return, and exhaust air dampers.
b. Conditions of filters.
c. Cooling coil, wet and dry bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings, including settings and percentage of maximum pitch diameter.
f. Settings for supply air, static pressure controller.
g. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.

F. Air Handling Unit Test Reports: For air handling units with coils, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Sheave dimensions, center-to-center and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static pressure differential in inches wg.

f. Preheat coil static pressure differential in inches wg.
g. Cooling coil static pressure differential in inches wg.
h. Heating coil static pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside air damper position.
l. Return air damper position.
m. Vortex damper position.

G. Apparatus Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside air, wet and dry bulb temperatures in deg F (°F).
e. Return air, wet and dry bulb temperatures in deg F (°F).
f. Entering air, wet and dry bulb temperatures in deg F (°F).
g. Leaving air, wet and dry bulb temperatures in deg F (°F).
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F (°F).

H. Gas Fired Heat Apparatus Test Reports: In addition to the manufacturer's factory startup equipment reports, include the following:

1. Unit Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner control types.

j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Entering air temperature in deg F (°F).
c. Leaving air temperature in deg F (°F).
d. Air temperature differential in deg F (°F).
e. Entering air static pressure in inches wg.
f. Leaving air static pressure in inches wg.
g. Air static pressure differential in inches wg.
h. Low fire fuel input in Btu/h.
i. High fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High temperature limit setting in deg F (°F).
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

I. Electric Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central station air handling units, include the following:

1. Unit Data: Include the following:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Face area in sq. ft.
f. Minimum face velocity in fpm.

2. Test Data: Include design and actual values for the following:

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering air temperature in deg F (°F).
e. Leaving air temperature in deg F(°F) .
f. Voltage at each connection.
g. Amperage for each phase.

J. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full load amperage and service factor,
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches,
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

K. Round, Flat Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F (°F).
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Design airflow rate in cfm.
h. Design velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

L. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

a. System and air handling unit identification.
b. Location and zone.
c. Test apparatus used.

d. Area served.
e. Air terminal device make.
f. Air terminal device number from system diagram.
g. Air terminal device type and model number.
h. Air terminal device size.
i. Air terminal device effective area in sq. ft.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F (°F).

M. Compressor and Condenser Reports: For refrigerant side of unitary systems, standalone refrigerant compressors, air cooled condensing units, or water cooled condensing units, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Unit make and model number.
d. Manufacturer's compressor serial numbers.
e. Compressor make.
f. Compressor model and serial numbers.
g. Refrigerant weight in lb.
h. Low ambient temperature cutoff in deg F (°F).

2. Test Data: Include design and actual values for the following:

a. Inlet duct static pressure in inches wg.
b. Outlet duct static pressure in inches wg.
c. Entering air, dry bulb temperature in deg F (°F).
d. Leaving air, dry bulb temperature in deg F (°F).
e. Control settings.
f. Unloader set points.
g. Low pressure cutout set point in psig.
h. High pressure cutout set point in psig.
i. Suction pressure in psig.
j. Suction temperature in deg F.
k. Condenser refrigerant pressure in psig.
l. Condenser refrigerant temperature in deg F (°F).
m. Oil pressure in psig.
n. Oil temperature in deg F (°F).
o. Voltage at each connection.
p. Amperage for each phase.
q. The kW input.

r. Crankcase heater kW.
s. Number of fans.
t. Condenser fan rpm.
u. Condenser fan airflow rate in cfm.
v. Condenser fan motor make, frame size, rpm, and horsepower.
w. Condenser fan motor voltage at each connection.
x. Condenser fan motor amperage for each phase.

N. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full load amperage and service factor.
p. Seal type.

2. Test Data: Include design and actual values for the following:

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full open flow rate in gpm.
e. Full open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

O. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

a. Instrument type and make.
b. Serial number.
c. Application.

d. Dates of use.
e. Dates of calibration.

3.10 ADDITIONAL TESTS

A. Within ninety (90) days of completing the testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near peak summer and winter conditions, perform additional inspections, testing, and adjusting during near peak summer and winter conditions.

PART 4 MEASUREMENT AND PAYMENT

Furnish labor, materials, equipment and services to store, transport, install, calibrate, and make operational the HVAC System. All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

DIVISION 25
INTEGRATED AUTOMATION

25 13 00 INTEGRATED AUTOMATION CONTROL AND MONITORING NETWORK SUPERVISORY CONTROL

25 13 13.01 GENERAL SCADA SYSTEM REQUIREMENTS

PART 1 GENERAL

1.1 DESCRIPTION

This section describes the general requirements for Supervisory Control and Data Acquisition (SCADA) System hardware, software, and implementation standards.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

A. Use standard hardware and software that is fully developed, tested, and supported as a base for the Work. Provide a fully operational system, which meets the functional intent and requirements of the Specifications.

B. Software Testing Standards

1. Consistent with the design parameters and that no errors occur when the programs are executed.
2. Establish Test programs at the factory to ensure that the software to be furnished is tested per the standards.

C. Revision Level available prior to start of OAD for all PLC and RTU computer equipment supplied under this Contract. This includes but is not limited to polling PLC, polling PLC configuration software, remote site RTU's, remote site RTU configuration software and remote site RTU operator. Provide the highest revision level of computer hardware and software interface modules. Provide highest software revision level available prior to start of GAD for all other computer equipment supplied under this Contract. Other computer equipment includes HMI servers, PC-based operator workstations and network switches.

D. Provide products that are supported by Microsoft Windows 2000 or later operating system and are included on the Windows 2000 compatibility list.

E. Provide software that layers on top of the Internet Protocol (IP).

F. Provide hardware that meets or exceeds the specified requirements for each installation location.

G. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL) and so marked or labeled, together with manufacturer's brand or trademark.

H. Provide material and equipment in accordance with applicable codes and standards, except as modified by the specifications.

2.2 SYSTEM HARDWARE

A. The System Integrator shall furnish the complete SCADA system. Additional hardware and ancillary equipment may be required to provide a fully functional SCADA System, which shall also be provided.

B. Provide surge protection as shown on the Contract Drawings.

C. Perform all installation, programming, testing, and calibration work as required to ensure a fully operational system.

2.3 SYSTEM INTEGRATION

A. Provide system integration of the complete SCADA System. System integration may require the installation of additional pieces of equipment to make the SCADA System a reliable, safe, maintainable and fully functional system. Such equipment includes, but is not limited to, wires, cables, connectors, power supplies, transceivers, transducers, signal isolators, power surge suppressors, lights, switches, circuit breakers, fuses, power receptacles, fans and communication devices.

B. Provide all additional pieces of equipment as necessary to provide a fully integrated, fully operational SCADA System with fully functional signal interfaces to remote RTU's and remote PC-based workstations.

C. System integration requires thorough testing of all system equipment and circuits under all probable system conditions to ensure a robust SCADA System.

2.4 SYSTEM PANELS

Panel design shall allow for easy access and removal of all components for performing maintenance, repair and replacement of components.

2.5 POWER SUPPLIES AND POWER CONDITIONING

A. Individually fuse power supply outputs and provide load fault protection. Provide protective circuit breakers for each hardware unit.

B. Equipment hardware which contains microprocessor-based controllers and which is not connected to an uninterruptible power supply with power conditioners.

2.6 CABLES AND CONNECTORS

A. Provide wiring, connectors and cables to connect the equipment.

B. Provide wiring and cables to equipment such as printers, operator workstations and similar devices to accommodate relocation within the control rooms and operator workstation areas. Add a minimum of twenty-five percent (25%) of the cable length or fifteen feet (15′); whichever is greater, to the laying lengths.

C. Clearly label all cables at both ends.

PART 3 EXECUTION

3.1 GENERAL

A. Provide the detailed hardware configuration, integration, construction, testing, startup, installation, and demonstration of all equipment.

B. Install all equipment at the City's facilities in accordance with applicable federal, state and local codes. Supervise the installation and be responsible for the performance of the completed system.

C. Provide for the protection, insurance and proper storage of equipment. In the event the equipment is damaged or stolen, for whatever reason, repair or replace, as required, the damaged equipment at no cost to the City until final acceptance.

D. Provide operations and maintenance manuals, record drawings, documentation and warranty as described elsewhere in the Specifications.

3.2 EXAMINATION

A. Verify equipment locations and delivery routes prior to installation to ensure the equipment will fit in the available space. Investigate and make any field modifications to allocated space for each panel to assure proper space and access (front, rear, side).

B. Existing raceways which contain space to run wiring may be used with the approval of the Engineer. Do not damage existing equipment or wiring. If equipment or wiring is damaged, repair or replace it at no additional cost to the City. Do not interrupt control or monitoring signals or power. Obtain approval from the City before pulling wires.

3.3 INSTALLATION

A. Provide temporary installations adjacent to existing equipment where noted.

B. After modifying existing equipment, dismantle temporary installations and restore to original condition.

3.4 PROTECTION

A. Maintain site security.

1. Check in with plant staff each day while on site.
2. Verify that all enclosures, doors, and gates which were opened during the day are locked when leaving.
3. Do not leave unlocked enclosures unattended.

3.5 INSTALLATION AND WIRING

A. Wire one-hundred twenty (120) VAC power to the SCADA System panels and the uninterruptible power supplies.

B. Provide and keep a neatly marked set of record wiring drawings on the job site showing the installed location and routing of all wiring, including spares, and instrumentation cable runs. These drawings shall also show all terminal connections. These drawings must show as a minimum:

1. All SCADA System communication wiring and interconnection.
2. All interconnections between any SCADA System components.
3. All power connections to SCADA System components, including uninterruptible power supply wiring.

C. Keep Drawings current with the Work as it progresses, subject to inspection by the Engineer at any time.

PART 4 MEASUREMENT AND PAYMENT

Furnish labor, materials, equipment and services to store, transport, install, calibrate, and make operational the SCADA System. Include wiring, raceway, fittings and connections to link the individual components into an integrated SCADA System. All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

25 13 13.02 SYSTEMS INTEGRATION

PART 1 GENERAL

1.1 DESCRIPTION

A. The Contractor shall obtain the services of a direct subcontractor who will be responsible for the coordination and integration of the entire instrumentation, process equipment and its control and associated signals into a completely functioning subsystem which will then seamlessly be interfaced into the existing plant system.

B. This Subcontractor will hereafter be referred to as the Systems Integrator. The Systems Integrator shall be a firm who is regularly engaged in the business of instrumentation and process control. The Contractor shall submit the Systems Integrator for approval as one of its major Subcontractors. The proposed Systems Integrator shall submit its work history and completed projects as they relate to its responsibilities on this project to the Contractor for inclusion in the subcontractor's approval process. The Systems Integrator may be required to furnish a performance bond in the amount of its Contract should the City feel that it would be in their best interest after reviewing its qualifications.

C. The Contractor's attention is directed to the fact that all the various parts and divisions of this Specification are meant to be integrated into one or more complete functioning subsystems that, when operating, has total compatibility with regard to signal, control, and process function with that of the plant's current system. The Contractor is to provide all materials, equipment, appurtenances, and services as necessary to achieve this end as specified herein and as shown on the Drawings.

1.2 SUBMITTALS

A. Submit: Manufacturers' literature, illustrations, shop drawings, specifications and engineering data including design performance, material, weights, dimensions and wiring diagrams. Submit shop drawings in accordance with 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).

B. Arrange and chair an initial meeting between the Contractor, Systems Integrator, major process equipment suppliers, related subcontractors, the City, and the Engineer to review the proposed shop drawing submittals, coordination method, form, and arrangement; also, to obtain any clarification of unclear items. This meeting should be held as quickly as possible after the Contractor receives its Notice to Proceed, but not longer than thirty (30) days after the award of the Contract.

C. Shop drawing submittals shall include the following:

1. Provide a complete one-line diagram showing all the new components being furnished by the Contractor for this project and how they integrate into the existing system.
2. Review submittals for completeness and compliance with the project's Specifications and existing project conditions. For all subsystem component wiring and control diagrams: combine and integrate them into one set of drawings showing all ISA-standard loop drawings, connection points, set points, PLC and DCS I/O addresses, wiring identification, and terminal numbers that are to be submitted for approval by the Contractor. Upon approval, one set will be kept at the jobsite during construction as reference drawings with the balance being included as part of the Operation and Maintenance Manuals. Elementary wiring diagrams need not be included unless required for clarity.

D. Shop Drawings: All equipment, components, accessories, wiring diagrams, control, and related parts shop drawings that are submitted by the various other divisions shall be first reviewed by the Systems Integrator for compliance with the master plan drawings developed at the initial meeting as called for in paragraph 1.2B; and to show its concurrence with the proposed submittal by marking each copy with the company's stamp prior to submittal to the City for its approval.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.1 GENERAL

A. Coordination

1. The System Integrator shall arrange and chair a second meeting between the Contractor, its equipment suppliers, and the related Subcontractors who are offering products and services on this project with regard to the process, process control, and the interface with existing conditions; and the representatives from the City's inspection, engineering, facilities, and design groups. The purpose of this

meeting is to coordinate and focus all of the Contractor's efforts into one master plan that will be submitted for approval as noted in Section 1.2 (submittals) for the complete project. The initial meeting and this second meeting are not part of the monthly progress meetings, but instead, are being held to organize how and in what form the Contractor is proposing to meet the project's requirements. The meeting will also serve as a review of the plan in detail for results and compliance to the plans, specs, and conditions while assuring that there are no remaining unanswered questions. This meeting should be held no later than ninety (90) days after notice to proceed.

2. Should either meeting or its process fail to be held or resolved, the Contractor forfeits its right to any delay or extra material claim against the City for any item or unresolved claim arising from issues that would have been resolved had the meetings been held.
3. Compliance with this section does not relieve any supplier or other subcontractor from meeting their division's requirements. Instead these sections efforts are in addition to those stated elsewhere in this Specification.

PART 4 MEASUREMENT AND PAYMENT

Furnish labor, materials, equipment and services to store, transport, install, calibrate, and make operational the system. Include wiring, raceway, fittings and connections to link the individual components into an integrated system. All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

DIVISION 26
ELECTRICAL
26 05 00 INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS

26 05 13 FACILITIES – MEDIUM-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 DESCRIPTION

This Section includes cables and related splices, terminations, and accessories for thirty-four thousand five-hundred (34,500) volt electrical distribution systems.

1.2 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Specification Sections.

1. Product data for control/signal transmission media.
2. Product certificates, acknowledged by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" article below.
3. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of architects and owners, and other information specified.
4. Field test reports indicating and interpreting test results.
5. Maintenance data for cables to include in the "Operating and Maintenance Manual" specified Contract Documents.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced and certified cable splicer to install, splice, and terminate medium voltage cable.

B. Manufacturer Qualifications: Firm experienced in manufacturing medium voltage cable and accessories similar to those indicated for this project, with a record of successful in-service performance.

C. Testing Firm Qualifications: In addition to the requirements specified in "Quality Control Services," an independent testing firm shall meet OSHA criteria for accreditation of testing Laboratories or shall be a full member company of the National Electrical Testing Association (NETA).

1. Testing Firm's Field Supervisor Qualifications: A person currently certified by the NETA or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in part 3.

D. Comply with NFPA 70 "National Electrical Code" for components and installation.

E. Product Test Reports: Certified reports of manufacturers' design and production tests indicating compliance of cable and accessories with referenced standards.

F. Comply with IEEE C2 "National Electrical Safety Code" for components and installation.

G. Listing and Labeling: Provide products specified in this section that are listed and labeled.

1. The terms "Listed and Labeled": As defined in the "National Electrical Code," article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA.

H. Single Source Responsibility: All medium voltage cable shall be the product of a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver medium voltage cable on factory reels conforming to NEMA WC 26. Store cables on reels on elevated platforms in a dry location.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work must be per the Contract Documents.

2.2 CABLES

A. Type: MV 90.

B. Conductor: Copper.

C. Conductor Stranding: Class B.

D. Insulation: Ethylene propylene rubber (EPR) conforming to NEMA WC 8 (ICEA 5 68 5 16).

E. Voltage Rating: Thirty-five (35) kV.

F. Insulation Thickness: One hundred thirty-three percent (133%) insulation level.

G. Shielding: Copper tape, helically applied over semiconducting insulation shield.

H. Three (3) Conductor Cable Assembly: Three (3) insulated, shielded conductors cabled together.

I. Circuit Identification: Color coded tape (black, red, blue) under the metallic shielding.

J. Jacket: Sunlight resistant PVC.

2.3 SPLICE KITS

A. Connectors: IEEE 404, compression type, as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended in writing by the splicing kit manufacturer for the specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions.

1. Heat shrink splicing kit of uniform cross section polymeric Construction with outer heat shrink jacket.
2. Premolded, cold shrink rubber, inline splicing kit.

2.4 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by the seal manufacturer for the type of cable and installation conditions, including orientation.

1. Cold shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
2. Heat shrinkable sheath seal kit with phase and ground conductor rejacketing tubes, cable end sealing boot, and sealing plugs for unused ground wire openings in boot.

B. Conductor Terminations: Comply with IEEE Standard 48, as indicated. Insulation class equivalent to that of the cable. Terminations for shielded cables include a shield grounding strap.

1. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress relief tube, multiple molded silicone rubber insulator modules, shield ground strap, and compression type connector.
2. Class 1 Termination for Shielded Cable: Heat shrinkable type with heat shrinkable inner stress control and outer nontracking tubes, multiple molded nontracking skirt modules, and compression type connector.

2.5 SOURCE QUALITY CONTROL

Test and inspect cables according to NEMA WC 7 and NEMA WC 8 before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

Examine raceways to receive medium voltage cables for compliance with installation tolerances and other conditions affecting performance of the cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install medium voltage cable as indicated, according to manufacturer's written instructions and IEEE 576.

1. Use NRTL listed and manufacturer approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
2. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable.
3. In manholes, handholds, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sagging.

3.3 GROUNDING

Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware according to manufacturer's written instructions.

3.4 IDENTIFICATION

Identify cable in accordance with the Contract Documents.

3.5 FIELD QUALITY CONTROL

A. Testing: Upon installation of medium voltage cable and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.2. Certify compliance with test parameters.

B. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

3.6 PROTECTION

Provide final protection and maintain conditions, in a manner acceptable to the manufacturer and installer, to prevent entrance of moisture into the cable and ensure that medium voltage cable is without damage or deterioration at substantial completion.

PART 4 MEASUREMENT AND PAYMENT

All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 05 19 FACILITIES – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 DESCRIPTION

This section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated six hundred (600) volts and less.

1.2 SUBMITTALS

Submit the following according to the Conditions of the Contract and Specification Sections.

1. Field test reports indicating and interpreting test results relative to compliance with performance requirements of testing standard.

1.3 QUALITY ASSURANCE

A. Testing Firm Qualifications: In addition to the requirements specified in "Quality Control Services," an independent testing firm shall meet OSHA criteria for accreditation of testing Laboratories or shall be a full member company of the National Electrical Testing Association (NETA).

1. Testing Firm's Field Supervisor Qualifications: A person currently certified by the NETA National Institute for Certification in Engineering Technologies to supervise on-site testing.

B. Comply with NFPA 70 "National Electrical Code" for components and installation.

C. Listing and Labeling: Provide products specified in this section that are listed and labeled.

1. The terms "Listed and Labeled": As defined in the "National Electrical Code," article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined by OSHA.

1.4 SEQUENCING AND SCHEDULING

A. Coordination: Coordinate layout and installation of cable with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver wire and cable according to NEMA WC 26.

PART 2 PRODUCTS

2.1 BUILDING WIRES AND CABLES

A. UL listed building wires and cables with conductor material, insulation type, cable Construction, and rating as specified in part 3.

B. Thermoplastic Insulation: Conforms to NEMA WC 5.

C. Solid conductor for 10 AWG and smaller; stranded conductor for larger than 10 AWG.

2.2 CONNECTORS AND SPLICES

UL listed factory fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with project's installation requirements and as specified in part 3.

PART 3 EXECUTION

3.1 EXAMINATION

Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Feeders: Type THHN/THWN, copper conductor, in raceway.

B. Branch Circuits: Type THHN/THWN, copper conductor, in raceway.

C. Fire Alarm Circuits: Type THHN/THWN, copper conductor, in raceway.

D. Class 1 Control Circuits: Type THHN/THWN, copper conductor, in raceway.

E. Class 2 Control Circuits: Type THHN/THWN, copper conductor, in raceway.

F. Applications indicated in Drawings calling for CLX continuously corrugated Interlocked Armor: Armor sheath shall be aluminum, XLPE insulation XHHW copper conductor in tray or conduit as indicated on Drawings.

3.3 INSTALLATION

A. Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and Construction debris and repair damaged finish, including chips, scratches, and abrasions. Install wires and cables as indicated, according to manufacturer's written instructions and the NEC "Standard of Installation."

B. Remove existing wire from raceway before pulling in new wire and cable.

C. Pull conductors into raceway simultaneously where more than one (1) is being installed in same raceway.

1. Use pulling compound or lubricant where necessary. Compound used must not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously where more than one (1) is being installed in same raceway.
2. Use pulling compound or lubricant where necessary. Compound used must not deteriorate conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.

E. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

F. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

G. Conductor Splices: Keep to minimum.

1. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
2. Use splice and tap connectors that are compatible with conductor material.

H. Wiring at Outlets: Install with at least twelve inches (12″) (three hundred (300) mm) of slack conductor at each outlet.

I. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL.

3.4 FIELD QUALITY CONTROL

A. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS. Certify compliance with test parameters.

B. Correct malfunctioning products at site, where possible, and retest compliance; otherwise, remove and replace with new units, and retest, to demonstrate compliance.

PART 4 MEASUREMENT AND PAYMENT

All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 05 20 FACILITIES – ELECTRICAL TESTING AND INSPECTION

PART 1 GENERAL

1.1 DESCRIPTION

Upon completion of the Work, the Contractor shall, in the presence of the Engineer, operate, test, adjust, and retest if necessary, the complete electrical system. The Contractor shall furnish all labor, material, supplies, equipment, instruments and power necessary for testing.

PART 2 PRODUCTS

2.1 GENERAL

All test information required by these Specifications shall be recorded and incorporated in a test report binder.

PART 3 EXECUTION

3.1 GENERAL

A. All buses, wiring, connections and contact making devices, etc., in the various equipment shall be inspected and cleaned prior to testing to determine that none of the equipment or connections are faulty prior to the application of tests.

B. The voltages on all the distribution systems shall be checked at no load and at full load.

3.2 NEW MEDIUM VOLTAGE CABLE TESTS

As outlined per NETA.

3.3 NEW GROUNDING SYSTEM TESTS

As outlined per NETA.

3.4 THE TESTS SHALL DEMONSTRATE THE FOLLOWING:

A. That all new lighting, power and control circuits provided under this Contract are continuous and free from short circuits.

B. That all new circuits provided under this Contract are free from grounds, and grounded where specified.

C. That the installation resistance to ground has all new ungrounded circuits provided under this Contract is not less than one (1) megohm at one thousand (1000) V DC.

D. That all new circuits and equipment provided under this Contract are properly connected in accordance with the applicable wiring diagrams, and are operable by demonstrating the functioning of each control device not less than ten (10) times or by continuous operation of each circuit for not less than one-half (1/2) hour.

E. Low potential tests shall apply to distribution systems operating below six hundred (600) volts. The low voltage tests shall be as specified in this section.

3.5 RELATED WORK SPECIFIED ELSEWHERE

Refer to 26 05 19, (Low Voltage Electrical Power Conductors and Cables) Low Voltage Cable or 26 05 13, (Medium Voltage Electrical Power Conductors and Cables) Medium Voltage Cable for wire, splices and terminations.

3.6 INDEPENDENT TESTING FIRM

A. The Contractor shall retain a qualified testing firm to provide inspections, tests, and evaluations to determine that the equipment designated is installed and adjusted for successful energizing and operation. The testing firm shall be a member in good standing of the National Electrical Testing Association (NETA), or as approved by the Engineer.

B. The testing firm shall provide a supervising engineering representative to interface with the installing Contractor and the Owner. Testing techniques shall be provided as required to do the Work under approved schedules.

C. Designated equipments shall be tested to verify operation and adjustment reports shall be issued documenting checks and test results.

D. The testing firm shall provide the following services:

1. Test on the five (5) kV cable.

3.7 QUALIFICATION OF TESTERS

A. The testing firm shall have two (2) or more years experience related to the testing of equipment designated herein. They shall be able to identify suitable engineering and technical resources to complete the Work under approved schedules.

B. The supervising engineering representatives shall have extensive knowledge of the products involved and at least two (2) years experience conducting tests. All testing shall be conducted under the direct supervision of the supervising engineering representative. The supervising engineering representative will prepare and sign reports and be available for consultation with the Engineer. The supervising engineer shall be a registered professional engineer and its seal shall be affixed to test reports.

C. Testing Technicians shall be trained and experienced on the testing they conduct and submit testing personnel resumes for approval prior to testing.

D. Testing equipment required to conduct the specified tests shall be furnished by the testing organization unless noted otherwise. Testing equipment shall be in good working order and comply with the requirements of applicable industry standards.

E. The testing firm shall utilize comprehensive report forms to document test results on all equipment and products. Upon completion of the Work, the report forms shall be signed by the supervising engineering representative and included in the final report. Report forms shall identify equipment by model number or by customer's identification number (where assigned). Report forms shall be submitted for the Engineer prior to such tests.

F. The testing firms shall collaborate with the manufacturer's representative.

3.8 SUBMITTALS

A. Submit name of Independent Testing Firm for approval by the Engineer prior to testing.

B. The test report binder shall be submitted for approval as part of the shop drawing requirements in accordance with provisions of 01 33 21, (Contract Documents, Working Drawings, Shop Drawings, and Product Data).

3.9 CONDITIONS

A. Testing shall not be done without written approval or the presence of the Engineer. The Contractor shall obtain from the manufacturer all data required to verify calibrations, to set and test equipment provided.

B. The Contractor shall notify, in writing, the Engineer at least seventy-two (72) hours prior to tests. The notice shall identify the test and the time that the test will be performed.

C. Tests shall be performed by an independent testing agency approved by the Engineer. Each two (2) technician field test crew shall include at least one (1) test technician who provides current certification by NETA.

PART 4 MEASUREMENT AND PAYMENT

All testing will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 05 23 CONTROL VOLTAGE ELECTRICAL POWER CABLES

26 05 23.01 FACILITIES – CONTROL/SIGNAL TRANSMISSION MEDIA

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes the following types of control and signal transmission media.

1. Coaxial cable.
2. Twisted pair cable.
3. Video pair cable.
4. Optical fiber cable.
5. Optical fiber connectors and couplers.

1.2 SUBMITTALS

A. General: Submit the following according to the conditions of the Contract and Specification sections.

B. Product data for control/signal transmission media.

C. Product certificates, acknowledged by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" article below.

D. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of architects and owners, and other information specified.

E. Field test reports indicating and interpreting test results.

F. Maintenance data for cables to include in the "operating and maintenance manual" specified in Contract Documents.

1.3 QUALITY ASSURANCE

A. Connected Equipment Manufacturer Certification: Where cables specified in this section are used to provide signal paths for systems specified in other sections of these Specifications, or for systems furnished under other Contracts, obtain review of the cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.

B. Optical Fiber Cable Installer Qualifications: Engage an experienced installer to install optical fiber cables.

C. Optical Fiber Cable Manufacturer Qualifications: Firms experienced in manufacturing products of this section similar to those indicated for this project that have a record of success in service performance.

D. Comply with NFPA 70 "National Electrical Code" for components and installation.

E. Listing and Labeling: Provide products specified in this section that are listed and labeled.

1. The terms "Listed and Labeled": As defined in the "National Electrical Code," article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined by OSHA.

F. Single Source Responsibility: All cable of each kind shall be the product of a single manufacturer.

PART 2 PRODUCTS

2.1 ELECTRONIC CABLE

A. Single Conductor Coaxial: Seventy-five (75) ohm characteristic impedance, solid polyethylene core, ninety-seven percent (97%) coverage, copper braid shield, polyethylene jacket; conforming to MIL C 1 7, Type RG 6AIU.

B. Direct Burial Coaxial: Single conductor, seventy-five (75) ohm characteristic impedance, 18 AWG copper clad, steel center conductor, solid polyethylene dielectric, 34 AWG bare copper braid outer conductor shield with ninety-five percent (95%) coverage, polyvinyl chloride (PVC) jacket.

C. Aerial Coaxial: Single conductor, seventy-five (75) ohm characteristic impedance, 18 AWG copper clad, steel center conductor, cellular expanded polyethylene dielectric, 34 AWG bare copper braid outer conductor shield with ninety-five percent (95%) coverage, ultraviolet resistant polyvinyl chloride (PVC) jacket.

D. Single Conductor Plenum Coaxial: Seventy-five (75) ohm characteristic impedance, solid bare copper central conductor, foamed Teflon dielectric, one hundred percent (100%) coverage tinned copper, double braid shield, Teflon jacket, suitable for installation in air handling spaces; conforming to MIL C 17, Type RG 1 1/U.

E. Twin Lead: Bare copper covered steel, two (2) conductor parallel, three hundred (300) ohm characteristic impedance, polyethylene insulation and web between conductors, cellular polyethylene oval jacket.

F. Multiconductor Cable: Quantity of conductors indicated; 18 AWG tinned copper conductors; color coded, low loss polyvinyl chloride (PVC) insulation; aluminum/mylar shield and 22 AWG tinned copper drain wire; PVC jacket.

G. Twisted Pair: Quantity of twisted pairs indicated; 22 AWG tinned copper conductors; color coded, polyvinyl chloride (PVC) insulation; overall aluminum/polyester shield and 22 AWG tinned copper drain wire; PVC jacket.

H. Video Pair: Balanced pair coaxial cable, one-hundred twenty-five (125) ohm characteristic impedance, 16 AWG soft drawn, bare copper conductors twisted to form pairs, expanded polyethylene core insulation, copper shielding tape, expanded polyester film covering.

2.2 OPTICAL FIBER CABLES AND CONNECTORS

Refer to Specifications.

PART 3 EXECUTION

3.1 EXAMINATION

Examine raceways and other elements to receive cable for compliance with installation tolerances and other adverse conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cable as indicated, according to manufacturer's written instructions.

1. Install transmission media without damaging conductors, shield, or jacket.
2. Do not bend cable, in handling or installation, to smaller radii than minimum recommended by manufacturer.

B. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously where more than one (1) is being installed in same raceway.
2. Use pulling compound or lubricant where necessary. Compound used must not deteriorate conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.

C. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

D. Use splice and tap connectors that are compatible with cable material.

1. Make no splices except at indicated splice points.

E. Bond shields and drains conductors to ground at only one (1) point in each circuit.

F. Connect components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.3 FIELD QUALITY CONTROL

A. Testing: Upon installation of cable and before energizing, demonstrate product capability and compliance with requirements.

1. Copper Cable Procedures: Inspect for physical damage and test cable for continuity and shorts. Use time domain reflectometer with strip chart recording capability and anomaly resolution to within twelve inches (12″) (three hundred (300) mm) in runs up to one thousand feet (1000') (three hundred (300) mm) in length. Test cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.
2. Optical Fiber Cable Procedures: Perform each visual and mechanical inspection and electrical test, including optional procedures, stated in NETA Standard ATS, Section 7.25. Certify compliance with test parameters and manufacturer's recommendations.

B. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.4 CLEANING

Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and Construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.5 DEMONSTRATION

A. Operate control/signal systems to demonstrate proper functioning. Replace malfunctioning cable with new materials, and then retest and recommission until satisfactory performance is achieved.

B. Train owner's maintenance personnel on procedures and schedules for start up and shutdown, troubleshooting, servicing, and preventive maintenance.

C. Review data in operating and maintenance manuals, refer to section "Operating and Maintenance Data."

D. Schedule training with City, through the Engineer, with at least seven (7) days' advanced notice.

PART 4 MEASUREMENT AND PAYMENT

All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 05 30 FACILITIES – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section explains the basic electrical processes and methods in the installation of electrical items.

B. This section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring. Raceways include the following:

1. Rigid metal conduit.
2. Flexible metal conduit.
3. Liquid tight flexible conduit.
4. Rigid nonmetallic conduit.
5. Wireway.

C. Boxes, enclosures, and cabinets include the following:

1. Device boxes.
2. Floor boxes.
3. Outlet boxes.
4. Pull and junction boxes.
5. Cabinets and hinged cover enclosures.

D. This Section includes underground conduits and ducts, duct banks, manholes, and other underground utility structures.

1.2 SUMMARY

A. This section includes the following electrical materials and methods:

1. Building wire, connectors, and splices for branch circuits and feeders.
2. Supporting devices for electrical components.
3. Concrete equipment bases.
4. Electrical demolition.
5. Cutting and patching for electrical Construction.
6. Touchup painting.
7. Raceways, Boxes and Cabinets.
8. Cable Trays.
9. Underground Ducts and Utility Structures.

1.3 DEFINITIONS

A. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, installed underground, embedded in earth or concrete.

B. Duct Bank: Two (2) or more conduits or other raceway installed underground in the same trench or concrete envelope.

C. Handhold: An underground junction box in a duct or duct bank.

D. Manhole: An underground utility structure, large enough for a person to enter, connecting with ducts to afford facilities for installing and maintaining cables.

1.4 SUBMITTALS

A. General: Submit each item in this article according to the conditions of the Contract.

B. Product Data for each type of product specified. Product data for surface raceway, wireway and fittings, floor boxes, hinged cover enclosures, and cabinets.

C. Shop drawings detailing fabrication and installation of supports and anchorage for electrical items. Shop drawings for nonstandard boxes, enclosures, and cabinets. Include layout Drawings showing components and wiring.

D. Coordination Drawings for electrical installation.

1. Prepare Computer Generated (CADD) Coordination Drawings to a one-half inch (1/2″) equals one foot (1′) scale or larger. Detail major elements, components, and systems of electrical equipment and materials in relation to each other and to other systems, installations, and building components. Indicate locations and space requirements for installation, access, and working clearance. Show where sequence and coordination of installations are important to the efficient flow of the Work. Coordinate drawing preparation with effort specified in other Specification sections. Include the following:

a. Provisions for scheduling, sequencing, moving, and positioning large equipment in the Work site during Construction.
b. Floor plans and elevations, including the following:

1) Clearances to meet safety requirements and for servicing and maintaining equipment.
2) Wall, roof, and foundation penetrations of cable and raceway and their relation to other penetrations and installations.
3) Sizes and locations of required concrete pads and bases.

c. Reflected ceiling plans to coordinate and integrate installing air outlets and inlets, light fixtures, alarm and communication systems components, sprinklers, and other ceiling mounted items.

1.5 CABLE TRAY

A. General: Submit the following according to the Conditions of the Contract and Specification Sections.

B. Product data for each component. Show tray types, dimensions, and finishes.

C. Shop drawings detailing fabrication and installation of cable tray, including Plans, elevations, sections, details of components, and attachments to other Construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice plate's connectors, expansion joint assemblies, straight lengths, and fittings.

D. Coordination Drawings, including floor plans and sections drawn to accurate scale. Show accurately scaled cable tray layout and relationships between components and adjacent structural and mechanical elements.

E. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of engineers and owners, and other information specified.

F. Factory certified test reports of specified products, conforming to NEMA VE 1.

G. Field test reports indicating and interpreting test results relative to compliance with performance requirements specified in "Field Quality Control" article of this section.

H. Maintenance data for cable tray, for inclusion in "Operating and Maintenance Manual" specified in Specifications. Include detailed manufacturer's instructions on tightening connections.

I. Product data for metal accessories for manholes and handholds, conduit and duct, duct bank materials, and miscellaneous components.

J. Shop drawings showing details and design calculations for precast manholes and handholds, including reinforcing steel. Stamp Drawings with seal of registered professional structural engineer.

K. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.

L. Inspection report for factory inspections, according to ASTM C 1037.

M. Coordination Drawings showing duct profiles and coordination with other utilities and underground structures. Include Plans and sections drawn to accurate scale.

N. Qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of architect and owner, and other information specified.

O. Field test reports indicating and interpreting test results relative to compliance with performance requirements of "Field Quality Control" article in Part 3 of this section.

P. Record Documents: Show dimensioned locations of underground ducts, handholds, and manholes.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. Listing and Labeling: Provide products specified in this section that are listed and labeled.

1. The terms "Listed and Labeled": As defined in the National Electrical Code, article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA.

C. Comply with NECA "Standard of Installation."

D. Coordinate layout and installation of raceway and boxes with other Construction elements to ensure adequate headroom, working clearance, and access.

E. Manufacturer Qualifications: Select a firm experienced in manufacturing cable trays similar to those indicated for this project and which has a record of success in service performance.

F. Single Source Responsibility: All cable tray components shall be the product of a single manufacturer.

G. Manufacturer Qualifications: Firms experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this project. Firm must have a record of success in service performance.

H. Comply with NFPA 70 "National Electrical Code" and ANSI C2 "National Electrical Safety Code" for components and installation.

I. Listing and Labeling: Provide products specified in this section that are listed and labeled.

1. The terms "Listed" and "Labeled": As defined in the "National Electrical Code," article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined by OSHA.

J. Coordinate layout and installation of ducts, manholes, and handholds with final arrangement of other utilities as determined in the field.

K. Coordinate elevations of duct and duct bank entrances into manholes and handholds with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to manholes and handholds and as approved by the Engineer.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of Construction to allow for electrical installations.

C. Coordinate installing required for supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for the efficient flow of the Work. Coordinate installing large equipment requiring positioning prior to closing in the building.

E. Coordinate connecting electrical service to components furnished under other sections.

F. Coordinate connecting electrical systems with exterior underground overhead services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where electrical items requiring access are concealed by finished surfaces. Access panels and doors are specified in section "Access Doors."

H. Coordinate installing electrical identification after completion of finishing where identification is applied to field finished surfaces.

I. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

J. Coordination: Coordinate layout and installation of cable tray with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

PART 2 PRODUCTS

2.1 BUILDING WIRE

A. Description: Single conductor, copper. Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.

B. Thermoplastic Insulated Wire: Conform to NEMA WC 5.

C. Cross Linked, Polyethylene Insulated Wire: Conform to NEMA WC 7.

D. Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated. Select to comply with project's installation requirements.

2.2 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B Flexible Metal Conduit: Zinc coated steel.

C. Liquid Tight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.

D. Fittings: NEMA FB 1, compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2, Schedule 40 or 80 PVC.

B. PVC Conduit and Tubing Fittings: NEMA IC 3; match to conduit or conduit/tubing type and material.

2.4 WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings, to match, and mate with wireway as required for complete system.

C. Select features where not otherwise indicated, as required to complete wiring system and to comply with NEC.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.5 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1.

B. Cast Metal Boxes: NEMA FB 1, type FD, cast ferroalloy box with gasketed cover.

2.6 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA QS 1.

B. Cast Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 CABINETS AND ENCLOSURES

A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged

door in front cover with flush latch and concealed hinge. Key latch to match panel boards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.8 CABLE TRAYS

A. Conform to NEMA VE 1.

B. Cable Trays, Fittings, and Accessories: Aluminum conforming to Aluminum Association alloy 6063 T6 for rails, rungs, and trays, 5052 H32 or 606 I T6 for fabricated parts.

C. Fabricate cable tray products with rounded edges and smooth surfaces.

2.9 SIZES AND CONFIGURATIONS

A. Ladder Type Trays: Class 20C unless indicated.

1. Width: Twelve inches (12″) (three-hundred five (305) mm) or as required by armored cable outside diameter.
2. Inside Depth: Four inches (4″) (one-hundred two (102) mm).
3. Cross Rung Spacing: Twelve inches (12″) (three-hundred five (305) mm) on center.
4. Minimum Fining Radius: Twenty-four inches (24″) (six-hundred ten (610) mm).

2.10 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, manufactured with the same materials and finishes as the cable trays.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by the cable tray manufacturer.

2.11 ACCESSORIES FOR UNDERGROUND DUCT

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacing and concrete cover depths indicated, while supporting ducts during concreting.

B. Frames and Covers: Cast iron with cast in legend ELECTRIC or SIGNAL as appropriate. Machine cover to frame bearing surfaces.

C. Sump Frame and Grate: Comply with FS RR F 621, Type VII for frame and Type I for cover.

D. Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert two inch (2″) (fifty (50) mm) diameter eye, one inch (1″) (twenty-five (25) mm) X four inch (4″) (one hundred (100) mm) bolt. Working load embedded in six inch (6″) (one-hundred fifty (150) mm), four thousand (4000) psi (twenty-seven and six-tenths (27.6) MPa) concrete: thirteen thousand pounds (13,000 lb.) (fifty-eight (58) kN) minimum tension.

E. Pulling and Lifting Irons in Floor: Seven-eighths inch (7/8″) diameter (twenty-one (21) mm), hot dipped galvanized, bent steel rod, stress relieved after forming, and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: forty thousand (40,000) pounds (180 kN) shear and sixty thousand (60,000) pounds (two-hundred seventy (270) kN) tension.

F. Bolting inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical resistant, nonconductive thermoplastic material; one-half inch (1/2″) (twelve (12) mm) internal diameter by two and three-quarters inches (2-3/4″) (sixty-eight (68) mm) deep, flared to one and one-quarter inch (1-1/4″) (thirty (30) mm) minimum at base. Tested ultimate pullout strength: Twelve thousand pounds (12,000 lb.) (fifty-three (53) kN) minimum.

G. Expansion Anchors for Installation after Concrete is Cast: Zinc plated carbon steel wedge type with stainless steel expander clip one-half inch (1/2″) (twelve (12) mm) bolt size, fifty-three hundred (5300) pound (twenty-four (24) kN) rated pull out strength, and sixty-eight hundred pound (6800 lb.) (thirty (30) kN) rated shear strength minimum.

H. Cable Stanchions: Hot rolled, hot dipped galvanized "T" section steel, two and one-quarter inch (2-1/4″) (fifty-six (56) mm) size, punched with fourteen (14) holes on one and one-half inch (1-1/2″) (thirty five (35) mm) centers for cable arm attachment.

I. Cable Arms: Three-sixteenths inch (3/16″) (five (5) mm) thick hot rolled, hot dipped galvanized sheet steel pressed to channel shape, approximately two (2); twelve inches (12″) (three hundred (300) mm) wide X fourteen inches (14″) (three-hundred fifty (350) mm) long and arranged for secure mounting in horizontal position at any position on cable stanchions.

J. Cable Support Insulators: High glaze, wet process porcelain arranged for mounting on cable arms.

K. Ground Rods: Solid copper clad steel, three-quarters inch (3/4″) (nineteen (19) mm) diameter X ten feet (10′) (three (3) m) length.

L. Ground Wire: Stranded bare copper, No. 6 AWG minimum.

M. Duct Sealing Compound: Nonhardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as thirty-five degrees (35°) F (one degree (1°) C), withstands temperature of three hundred degrees (300°) F (one-hundred forty-nine degrees (149°) C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

2.12 CONDUIT AND DUCT

A. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 or 80 PVC, rated for use with ninety degrees (90°) C conductors under all installation conditions.

B. PVC Conduit and Tubing Fittings: NEMA TC 3.

C. Manufactured Bends: Not less than thirty-six inch (36″) (nine hundred (900) mm) radius.

2.13 UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES

A. Precast Units: Interlocking, mating sections, complete with accessory items, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod. Inside dimensions shall be six feet (6′) wide X six feet (6′) high X six feet (6′) deep, at a minimum.

B. Design structure according to ASTM C 858.

C. Structural Design Loading: ASTM C 857, Class A 16.

D. Fabricate according to ASTM C 858.

E. Joint Sealant: Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.

F. Source Quality Control: Inspect structures according to ASTM C 1037.

G. Cover Legend: Electric.

2.14 FIRESTOPPING

A. Materials: UL listed and labeled and FM approved for fire ratings consistent with penetrated barriers.

B. Materials: NRTL listed and labeled for fire ratings consistent with penetrated barriers.

C. Sleeves: Schedule 40, welded, black steel pipe sleeves. Sizes as indicated or minimum NEC size for cable or cable group to be installed.

D. Sealing Fittings: Suitable for sealing cables in sleeves or core drilled holes.

E. Sealing Mortar: Suitable for sealing cable penetration slots/openings in fire barriers.

F. Sealant: One (1) part compound for sealing cables, sleeves, and openings in fire barriers.

2.15 WARNING SIGNS

A. Lettering: One and one-half inch (1-1/2″) (forty (40) mm) high, black on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and Fastening: Conform to "Electrical Identification."

C. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

2.16 SUPPORTING DEVICES

A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.

1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.

2. Metal Items for Use Outdoors or in Damp Locations: Hot dip galvanized steel, except as otherwise indicated.

B. Steel channel supports have nine-sixteenths inch (9/16″) (fourteen (14) mm) diameter holes at a maximum of eight inches (8″) (two-hundred three (203) mm) on center in at least one (1) surface.

1. Fittings and accessories mate and match with channels and are from the same manufacturer.

C. Nonmetallic Channel and Angle Systems: Structural grade, factory formed, fiberglass resin channels and angles with nine-sixteenths inch (9/16″) (fourteen (14) mm) diameter holes at a maximum of eight inches (8″) (two-hundred three (203) mm) on center in at least one (1) surface.

1. Fittings and accessories mate and match with channels or angles and are from the same manufacturer.
2. Fitting and Accessory Material: Same as channels and angles, except metal items may be stainless steel.

D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or "click" type hangers.

E. Sheet Metal Sleeves: Two-hundred seventy-six ten-thousandths inch (0.0276″) (seven tenths (0.7) mm) or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable iron casting with hot dip galvanized finish.

H. Expansion Anchors: As specified in Contract Documents.

I. Toggle Bolts: All steel springhead type.

2.17 CONCRETE EQUIPMENT BASES

A. Forms and Reinforcing Materials: As specified in Specification "Cast-in-Place Concrete."

B. Concrete: Three thousand (3000) psi (twenty and seven-tenths (20.7) MPa), twenty-eight (28) day compressive strength as specified in "Cast-in-Place Concrete."

2.18 TOUCH UP PAINT

A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.

B. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

C. For Galvanized Surfaces: Zinc rich paint recommended by item manufacturer.

2.19 SOURCE QUALITY CONTROL

A. Perform design and production tests on cable tray according to NEMA VE 1.

2.20 CONSTRUCTION MATERIALS

A. Brick: Conform to ASTM C 55, concrete brick Type I, Grade N.

B. Mortar: Conform to ASTM C 270, Type M, except for quantities less than two (2.0) cu. ft. (60 L), where packaged mix complying with ASTM C 387, Type M may be used.

C. Concrete: Conform to "Cast-in-Place Concrete" for concrete and reinforcing.

1. Strength: Four thousand (4000) psi minimum twenty-eight (28) day compressive strength.
2. Aggregate for Duct Encasement: Three-eighths inch (3/8″) (ten (10) mm) maximum size.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

A. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.

B. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Reconnect for case of disconnecting, with minimum interference with other installations.

D. Give right-of-way to raceways and piping systems installed at a required slope.

E. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

F. Examine surfaces to receive cable tray for compliance with installation tolerances and other required conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Feeders: Type THHN/THWN, copper conductor, in raceway, except as otherwise indicated.

B. Branch Circuits: Type THHN/THWN, in raceway.

C. Class 2 and Class 3 Control Circuits: Type THHN/THWN, in raceway.

D. Outdoors: Use the following wiring methods:

1. Exposed: Rigid metal conduit.
2. Concealed: Rigid metal conduit.
3. Underground, Single Run: Rigid nonmetallic conduit.
4. Underground, Grouped: Rigid nonmetallic conduit.
5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor driven equipment): Liquidtight flexible metal conduit.
6. Boxes and Enclosures: NEMA Type 4X AISI Type 316 brushed stainless steel.

E. Indoors: Use the following wiring methods:

1. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor driven equipment): Liquidtight flexible metal conduit.
2. Damp or Wet Locations: Rigid steel conduit.
3. Exposed: Rigid steel conduit.
4. Concealed: Rigid steel conduit.
5. Boxes and Enclosures: NEMA Type 4X AISI Type 316 bushed 316 stainless steel.

F. Use cable tray of indicated types and sizes, complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adapters, hold down devices, grommets, and blind ends.

3.3 ELECTRICAL SUPPORTING METHODS

A. Damp Locations and Outdoors: Hot dip galvanized materials or nonmetallic, U channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click type clamp system.

D. Conform to manufacturer's recommendations for selecting supports.

E. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least four (4), two hundred pounds (200 lbs) (ninety (90) kg), minimum design load.

3.4 INSTALLATION

A. Install wires in raceway according to manufacturer's written instructions and NECA's "Standard of Installation."

B. Conductor Splices: Keep to the minimum and comply with the following:

1. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
2. Use splices and tap connectors that are compatible with conductor material.

C. Wiring at Outlets: Install with at least twelve inches (12″) (three hundred (300) mm) of slack conductor at each outlet.

D. Connect outlets and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

E. Install devices to securely and permanently fasten and support electrical components.

F. Raceway Supports: Comply with NFPA 70 and the following requirements:

1. Conform to manufacturer's recommendations for selecting and installing supports.
2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
3. Support parallel runs of horizontal raceways together on trapeze or bracket type hangers.
4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a twenty-five percent (25%) minimum in the future.
5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.
6. Hanger Rods: One-quarter inch (1/4″) (six (6) mm) diameter or larger threaded steel, except as otherwise indicated.
7. Spring Steel Fasteners: Specifically designed for supporting single conduits or tubing. May be used in lieu of malleable iron hangers for one and one-half inch (1-1/2″) (thirty-eight (38) mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to channel and slotted angle supports.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports, with no weight load on raceway terminals.

G. Vertical Conductor Supports: Install simultaneously with conductors.

H. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panel boards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.

I. In open overhead spaces, cast boxes threaded to raceways need not be separately supported, except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than twenty-four inches (24″) (six-hundred ten (610) mm) from the box.

J. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core drilled holes are used. Install for cable and raceway penetrations of masonry and fire rated gypsum walls and of all other fire rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

K. Firestopping: Apply to cable and raceway penetrations of fire rated floor and wall assemblies. Perform firestopping as specified in "Firestopping" to reestablish the original fire resistance rating of the assembly at the penetration.

L. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:

1. Fasten by means of wood screws or screw type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring tension clamps on steel.
2. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.
3. In partitions of light steel Construction use sheet metal screws.
4. Drill holes in concrete beams so holes more than one and one-half inches (1-1/2″) (thirty-eight (38) mm) deep, do not cut main reinforcing bars.
5. Drill holes in concrete so holes more than three-quarters inch (3/4″) (nineteen (19) mm) deep, do not cut main reinforcing bars.
6. Fill and seal holes drilled in concrete and not used.
7. Select fasteners so the load applied to any fastener does not exceed twenty-five percent (25%) of the proof test load.

M. Install concrete pads and bases according to requirements of "Cast-in-Place Concrete."

N. Install cable tray level and plumb according to manufacturer's written instructions, rough in Drawings, the original design, and referenced standards.

O. Remove burrs and sharp edges of cable trays.

P. Fasten cable tray supports securely to the building structure.

1. Locate and install supports according to recommendations of NEMA VE 1.
2. Design supports, including fastenings to the structure, to carry the greater of the calculated load multiplied by a safety factor of four (4), or the calculated load plus two hundred pounds (200 lbs) (ninety (90) kg).

Q. Make connections to equipment with flanged fittings fastened to the tray and to the equipment. Support the tray independently of fittings. Do not carry the weight of the tray on the equipment enclosure.

R. Install expansion connectors in cable tray runs that exceed ninety feet twenty-seven inches (90′ 27″). Space connectors and set gaps according to NEMA VE 1.

S. Make changes in direction and elevation using standard fittings.

T. Make cable tray connections using standard fittings.

U. Locate cable tray above piping except as required for tray accessibility and as otherwise indicated.

V. Fire stop penetrations through fire and smoke barriers, including walls, partitions, floors, and ceilings, after cables are installed.

W. Sleeves for Future Cables: Install capped sleeves for future cables through fire stopped cable tray penetrations of fire and smoke barriers.

X. Working Space: Install cable trays with sufficient space to permit access for installing cables.

3.5 RACEWAY, BOXES AND CABINETS INSTALLATIONS

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Conceal conduit, unless otherwise indicated, within finished walls, ceilings, and floors.

C. Keep raceways at least six inches (6″) (one-hundred fifty (150) mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

D. Install raceways level and square and at proper elevations. Provide adequate headroom.

E. Complete raceway installation before starting conductor installation.

F. Use temporary closures to prevent foreign matter from entering raceway.

G. Protect stub ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

H. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

I. Use raceway fittings compatible with raceway and suitable for use and location.

J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building Construction and obstructions, except as otherwise indicated.

K. Raceways Embedded in Slabs: Install in middle third of the slab thickness where practical, and leave at least one inch (1″) (twenty-five (25) mm) concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in the concrete.
3. Run conduit larger than one inch (1″) trade size (size 27) parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
4. Transition nonmetallic tubing to rigid steel conduit before rising above floor.

L. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

M. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

N. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one (1) locknut, use two (2) locknuts, one inside and one outside the box.

O. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

P. Install pull ropes in empty raceways. Use one-quarter inch (1/4″) nylon rope with a minimum tensile strength of four hundred pounds (400 lb.). Leave not less than twelve inches (12″) (three hundred (300) mm) of slack at each end of the pull rope.

Q. Telephone and Signal System Raceways Two Inch (2″) Trade Size (Size Fifty-Three (53)) and Smaller: In addition to the above requirements, install in maximum lengths of one-hundred fifty feet (150′) (forty-five (45) m) and with a maximum of two (2) ninety degree (90°) bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

R. Install raceway sealing fittings according to the manufacturers written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from an underground duct bank or conduit run to an above grade box or equipment cabinet.
2. Where conduits enter or leave hazardous locations.
3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air conditioned spaces.
4. Where otherwise required by the NEC.

S. Stub Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used six inches (6″) (one-hundred fifty (150) mm) above the

floor. Where equipment connections are not made under this Contract, install screwdriver operated threaded flush plugs flush with floor.

T. Flexible Connections: Use maximum of six feet (6′) (one-thousand eight-hundred thirty (1830) mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

U. Set floor boxes level and adjust to floor surface.

V. Install hinged cover enclosures and cabinets plumb. Support at each corner.

W. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.6 GROUNDING

Connect cable trays to ground as instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.7 FIELD QUALITY CONTROL

A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.

B. Anchorage: Test pullout resistance of one (1) of each type, size, and anchorage material for toggle bolts and powder driven threaded studs.

1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain Architect's approval before transmitting loads to the structure. Test to ninety percent (90%) of rated proof load for fastener.

C. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.8 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touch up coating recommended by the manufacturer.

3.9 DEMOLITION

A. Where electrical Work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work Indicated to be Demolished: Remove exposed electrical installation in its entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, two inches (2″) (fifty (50) mm) below the surface of adjacent Construction. Cap and patch surface to match existing finish.

D. Removal: Remove demolished material from the Project site.

E. Temporary Disconnection: Remove, store, clean, reinstall, reconnect and make operational components indicated for relocation.

3.10 CUTTING AND PATCHING

A. Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3.11 CLEANING

Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and Construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.12 APPLICATION

A. Underground Ducts for Building Electrical Service: Plastic Schedule 40 PVC conduit encased in concrete.

B. Underground Ducts for Single Run Electrical Feeders: Direct buried Schedule 80 PVC conduit.

C. Manholes: Underground precast concrete utility structures.

3.13 EXAMINATION

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.14 EARTHWORK

A. Excavation and Backfill: Conform to earthwork Specification but do not use heavy duty, hydraulic operated compaction equipment.

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable lying, and other Work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

C. Restore disturbed paving. Refer to Specification 32 01 30.10, (Patch Existing Pavement and Reset Utility Service).

3.15 CONDUIT AND DUCT INSTALLATION

A. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of four inches (4″) per one hundred feet (100′) one to three hundred ratio (1:300) to drain toward manholes and handholds and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of twenty-five feet (25′) (seven and five-tenths (7.5) m) both horizontally and vertically at other locations.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Duct Entrances to Manholes and Handholds: Space end bells approximately ten inches (10″) (two hundred fifty (250) mm) on center for five inch (5″) (one-hundred twenty-five (125) mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end bell spacing ten feet (10′) (three (3) m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

F. Building Entrances: Transition from underground duct to conduit ten feet (10′) (three (3) m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Concrete Encased Ducts: Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Direct Buried, Nonencased Duct Entering Nonwaterproofed Walls: Install a Schedule 40 galvanized steel pipe sleeve for each duct. Caulk space between conduit and sleeve with duct sealing compound on both sides for moisture tight seal.

3. Waterproofed Wall and Floor Entrances: Install a watertight entrance sealing device with the sealing gland assembly on the inside. Anchor device into masonry Construction with one (1) or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

G. Separation Between Direct Buried, Nonencased Ducts: Three inches (3″) (seventy-five (75) mm) minimum for like services, and six inches (6″) (one-hundred fifty (150) mm) minimum between power and signal ducts.

H. Concrete Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating.

PART 4 MEASUREMENT AND PAYMENT

All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 05 31 FACILITIES – INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

This section includes the furnishing and installation of instrumentation and controls for City Facilities. Analog, control, status, and alarm signals required for alarm, display and report generation shall be transmitted to the existing appropriate control panel as indicated on the Drawings.

1.2 REFERENCES

A. Applicable References: The following codes and standards shall apply:

1. IEEE — Institute of Electrical and Electronic Engineers.
2. ISA — Instrument Society of American Standards.
3. ANSI — American National Standards Institute.
4. AWWA — American Water Works Association Standards.
5. JIC — Joint Industrial Council.
6. OSHA — Occupational Safety and Health Act.
7. NEC — National Electrical Code.

1.3 SUBMITTALS

A. Submit manufacturers' literature, illustrations, shop drawings, Specifications and engineering data including design performance, material, weights, dimensions and wiring diagrams.

B. Prepare and submit comprehensive wiring diagrams for the instrumentation Work performed under this section. Drawings shall include the following:

1. Control wiring diagrams and ISA standard loop Drawings with terminal numbers and all control devices identified. Loop Drawings shall be one (1) per sheet. The sheets shall be eight and one-half inches by eleven inches (8-1/2″ X 11″) or eleven inches by fourteen inches (11″ X 14″) in size.
2. Drawings showing sizes and locations of all equipment and their control locations.
3. Wiring diagrams shall contain internal and external ladder wiring schematics, with identified terminal numbers, relays and other control devices. Control electrical diagrams shall be drawn with circuitry arranged in functional sequence on ladder type diagrams. Each horizontal line on the ladder diagram shall be assigned a number, which, shall be written to the left or right of the ladder. Relay coils shall be drawn on the right side of the ladder. The line numbers on which the relay contacts appear shall be shown on the right of each coil. A normally closed contact shall be designated by drawing a diagonal line through the contact. Timed contacts shall be designated by letter "T" under the line number. Instrument logic diagrams and schematics shall be prepared using ISA 55.1, IEEE 315 and 315A, and NEMA standard symbols and identification letters.
4. All Drawings shall be submitted in a timely manner to allow for engineering review, and incorporation of additions or modifications.
5. Provide a list of all parts including numbers and quantities.
6. Final as built Drawings shall also be furnished on diskettes compatible with Intergraph or AutoCAD formats.
7. Control panels furnished by Contractor shall include panel layout Drawings and associated wiring schematics as defined above.

C. Provide preliminary copies of the installation, operation, and maintenance manual (O&M). The submission and approval of the preliminary manual does not constitute final approval; the preliminary copy shall be used during field start up, and testing. The final O&M Manual shall be submitted four (4) weeks (no later) after approval of the Final Acceptance Test. This manual shall reflect all field changes made during start up, i.e., final instrument calibration, tuning, set points, software changes, etc. Include the following elements in each manual in addition to all submittal items listed above.

1. Erection and installation sequence and instructions.
2. Exploded view Drawings and illustrations with sequence description for assembly and disassembly of equipment.
3. Comprehensive parts and materials list for each equipment element indicating manufacturer and manufacturer's identification number. Include name, address, and telephone number of sales and service office nearest project site for each major equipment item.
4. Schedules of recommended spare parts to be stocked, including part number, inventory quantity, and ordering information.
5. Performance rating and nameplate data for each major system component.
6. Procedures for starting, operating, adjusting, calibrating, testing, and shutting down system equipment.
7. Emergency operating instructions and trouble shooting guide.
8. Schedule of routine maintenance requirements and procedures, and preventative maintenance instructions required to insure satisfactory performance and equipment longevity.

9. Maintenance instructions for extended out-of-service periods.
10. Complete listing of all software programming and licensing agreements.
11. Complete Operator's Supervisors Manual for the Control System which includes system hardware and software, and the "how to's" of the system.
12. Testing Reports.
13. ISA Specification Sheets, filled out to reflect final field instrument calibration, purchased model number and any other as built conditions.
14. As built shop drawings of panels, wiring, instruments, etc.
15. All standard O&M manuals for all equipment.

1.4 QUALITY ASSURANCE

A. Equipment Manufacturer Qualifications: The equipment shall be the standard products of a manufacturer who has been regularly engaged in the successful production of high quality equipment and systems of the type specified for at least ten (10) years, has supplied such instrumentation equipment for at least five (5) years of the ten (10) year period, and has at least three (3) installations in successful operation for at least five (5) years.

B. The supplier shall assume complete system responsibility for the adequate and proper operation of all equipment furnished regardless of original source or manufacturer.

C. Code Compliance: Any special standard or code requirements of the state, local regulatory body and other regulatory agency shall also apply herein. Where a conflict arises between codes, the one containing the more stringent requirements as determined by the Engineer shall apply.

D. Examination of Equipment for Safety: Equipment and materials installed within control cabinets shall be UL listed, labeled or identified.

1. Equipment and materials shall have been tested by a testing laboratory, and shall meet, or exceed, nationally recognized standards, or have been found suitable for use in the specific manner as intended by the Engineer.
2. Equipment and materials utilized shall be included within published listings prepared by testing Laboratories, inspection agencies or other organizations concerned with product evaluations.

E. Field test all equipment specified under this section to the full satisfaction of the Engineer so that each part and all components together function in the manner intended.

F. The intent of the Specifications and Drawings covering the instrumentation is to outline the design concept and control mode of the instrumentation system. It also defines the various functions, which are to be measured, monitored, and controlled. The various types of instruments and controls have been selected as best for the intended service and, where practical, the name and model number of a particular manufacturer has been given.

G. No attempt should be made on the Drawings or in the Specifications to list all of the accessory hardware, such as mounting hardware, screws, stops, connectors, which may be required to augment the instrumentation equipment. Nevertheless, furnish all these accessories, where required, to the degree that the connecting wiring between terminal blocks on the panels and field wiring is all that is required to complete the instrumentation system.

H. Verify from the supplier the maximum and minimum temperature and maximum relative humidity for storing the equipment, and conform to the supplier's requirements. In any case, the minimum storage requirements will be not less than fifty degrees (50º) F. Protect the equipment from humid conditions, which might cause corrosion of the electrical and electronic parts of the equipment by providing desiccant cartridges in all enclosures and power to all heaters. Failure to store equipment in the specified or approved manner shall be sufficient reason for not accepting the equipment, regardless of the outside appearance or warranty of the manufacturer. Protect all electronic equipment from a dusty environment by sealing the equipment in plastic, etc.

I. All control and instrument panels shall be prewired and, where practical, the instruments shall be premounted before delivery to the job site. Where it is not practical to premount the instruments, the Contractor shall be responsible for the Work of mounting and wiring the instrument at the job site. Any field modifications to existing equipment or wiring required, shall be the responsibility of the Contractor. All fieldwork shall be performed under the prevailing labor conditions.

J. Verify type, quantities and locations of all wiring required to interconnect instrumentation system components, consoles and panels.

K. No form of energy shall be turned on to any part of the instrumentation system prior to receipt by the Engineer of a certified statement of approval of the installation from the Contractor containing authorization for energizing the system.

L. Provide the supervisory services of a factory trained service person who is specifically trained on the types of equipment herein specified to assist the Contractor during Construction in the location of sleeves, methods of installing conduit and special cable, mounting, piping, and wiring of one (1) of each type of device; and the methods of protecting all of the equipment prior to placing it into service.

M. Upon completion of the installation, provide the services of the service person for adjustment, calibration, and start up of the equipment. After acceptance of the final performance test, provide the above service person for a minimum of one eight (8) hour day to instruct the plant operators in the operation and maintenance of the control systems. The instrumentation supplier shall provide sufficient service to place the complete instrumentation system in satisfactory operation, as determined by the Engineer, and maintain it for one (1) year.

N. Instrumentation supplier shall take whatever steps necessary to insure that its instrumentation operates satisfactorily with the electrical power supplied by the City. This includes installation of isolation transformers, surge suppressors, lightning arrestors, etc. as needed.

1.5 PROJECT CONDITIONS

A. Instrumentation Requirements:

1. All instruments and devices furnished under this item, except two (2) wire transmitters or as otherwise specified, shall be suitable for operation on nominal one-hundred twenty (120) volt, sixty (60) Hz, single phase power sources.

2. The electronic signal referred to throughout these Specifications shall be four to twenty (4 to 20) mA unless otherwise noted. Signal isolation shall be furnished for the input of each receiver where an analog signal is transmitted to more than one (1) receiving device in an analog control loop or an alarm loop, in accordance with ISA Standard 550.1.
3. All instruments furnished for front panel mounting shall be the same NEMA rating as the panel and suitable for flush mounting, vertical or angle mounted as required by panel design and shall have black satin finish cases.
4. All instruments shall return to normal operation upon restoration of power after a power failure. All instruments shall be wired in the proper fail safe manner to indicate an alarm condition at the signal destination(s) on loss of power.
5. An internal or an attached external "On Off" disconnect switch shall be provided for each field located instrument or transmitter requiring one-hundred twenty (120) volt electric power connections. This shall be furnished so that each piece of field located equipment can be electrically isolated for repair and maintenance without shutting down the power at a power distribution panel.
6. All instruments shall be provided with transient voltage surge suppressors (TVSS) on both power and signal lines. Panels shall be provided with TVSS on power lines.
7. System and instrument shielding shall be grounded in accordance with the manufacturer's recommended grounding requirements.
8. All DCS panels will contain the most efficient utilization of I/O modules to meet the I/O requirements defined in the Specifications.
9. All one-hundred twenty (120) volt wire shall be routed in separate conduits from four to twenty (4 to 20) mA wiring at all times.

B. System Requirements:

1. It shall be the supplier's responsibility to furnish a complete and functional integrated process measurement and control system.
2. Systems integration responsibility shall include review of all appropriate Drawings and Specification sections for this entire project. This shall include review of Specifications for variable frequency drives, pumps, valves, feed equipment, and any other equipment interfacing to the system, as required to provide necessary wiring schematics and compliance with the functional requirements of these Specifications.
3. All special cables, such as sensor/transmitter specialty interconnection wiring, or data highway integration cabling shall be furnished by the system supplier for installation by the Contractor, under the direction of the supplier. Data highway integration cabling shall be per manufacturer's recommendation and shall represent the most effective mode of transmitting the required signals to the existing PCS.

PART 2 PRODUCTS

2.1 CONTROL ENCLOSURES

A. System Description: Contractor shall provide control system enclosures of the functionality, size rating and Specifications required in the Contract Documents.

B. Construction:

1. Construction: NEMA enclosure of brushed AISI Type 316 Stainless steel shall be reinforced as required; equipped with hardware, including continuous piano hinge, quick release latches, and print pocket on inside face of door.

a. Console bodies shall be molded to form a one (1) piece unit requiring no metal strips to form mechanical joints.
b. Back plates shall be unpainted aluminum.
c. Provide enclosures with full size wiring diagrams within print pocket.

2. Agency Certification: Construct electrical control panels in accordance with the requirements of the Underwriters Laboratory (UL). Provide evidence that both UL listings and approvals and the National Electrical Manufacturers' Association (NEMA) standards and requirements have been met by conspicuously affixed stamps and seals on the electrical apparatus forming parts of the polymer system where applicable.
3. Design Features: Provide control panels with the following:

a. Panels shall be completely factory wired and assembled, equipped with all necessary appurtenances mounted within as required for a complete installation, and ready for field connection of external wiring to terminal blocks. All enclosure mounted instruments, indicators, and controls shall also be wired to terminal blocks.
b. Except as specifically indicated, provide panel with a main circuit breaker for over current protection of the panel and to serve as a main disconnect. The circuit breaker shall be sixty-five (65) k AIC rated and shall be equipped with an external operating handle interlocked with the control panel door such that the breaker handle must be switched to the off position before the door can be opened. A mechanism shall be provided to permit authorized personnel to defeat this safety feature in order to work on the panel while it is energized.
c. Provide digital display units with retransmission capability or signal isolators for isolation of transmitted signals. Provide interposing relays for isolation of discreet signals.
d. Provide panel with control power transformers with primary and secondary fusing.
e. Provide miscellaneous panel equipment as specified in the Contract Documents.

4. Identification (i.e., nameplates, legend plates, and tags): All nameplates, legend plates, labels and tags shall conform to ISA recommended practice publication ISA RP6O 6.

a. Nameplates: Nameplates shall be used to display basic information including function.
b. Nameplates shall be made of laminated engraving stock having a black core with a white surface. Letters shall be gothic upper case (capital letters); minimum height shall be one-eighth inch (1/8″) with a three sixty-fourth inch (3/64″) space between lines.
c. The characters shall be engraved using an industry standard engraving machine.
d. Nameplates shall be attached to the enclosure using Type 316 stainless steel screws.
e. Enclosure identification nameplates shall be larger sized letters, three-sixteenths inch (3/16″) minimum.
f. Abbreviations shall conform to Appendix B of ISA recommended practice publication ISA RP6O 6.
g. Margins shall conform to the following:

1) With holes:

a) Top/bottom — One-sixteenth inch (1/16 ″) mm
b) Sides left/right — Five-sixteenths inch (5/16″) mm

2) Without holes:

a) Top/bottom — One-sixteenth inch (1/16″) mm
b) Sides left/right — One-eighth inch (1/8″) mm

h. Legend Plates: Legend plates shall be used to display basic functions of push buttons, selector switches and pilot lights.

1) Legend plates shall be made of laminated engraving stock having a black core with a white surface. Letters shall be gothic upper case (capital letters) minimum height shall be one-eighth inch (1/8″) with a three-sixty-fourth inch (3/64″) space between lines.
2) The characters shall be engraved using an industry standard engraving machine.
3) Legend plates shall be held to the enclosure by the ring nuts used to hold the operator in place.
4) All legend plates for a particular panel shall be of the same size and shape.

i. Wire Markers: Each wire shall be identified on both ends of the wire with wrap around of shrink type wire markers. The wire marker number shall be a unique number that shall be easily cross referenced with schematic Drawings.

j. Adhesive Labels: Adhesive labels shall be used inside the panel to identify equipment. The labels shall be smudge proof and shall have an adhesive back. The printing on the labels shall be done by mechanical means only.

k. Wiring: All wiring shall conform to National Electric Code's latest revision article 310 "Conductors for General Wiring," table 310 17. All wire shall be copper.

1) Control wiring shall be a minimum size of fourteen (14) gauge, six hundred (600) volt, type THHN. Power wiring shall be twelve (12) gauge six hundred (600) volt type THHN sized as required.
2) All analog signal wiring shall be a minimum size of eighteen (18) gauge twisted pairs with foil shield and drain wire. The insulation shall be six hundred (600) volt; ninety degrees (90°) C. Drain wires shall be grounded at the panel only.
3) All wiring shall conform to the following color code:

a. One-hundred twenty (120) VAC power wires one (1) phase i.e., lights, heaters: Black hot and white neutral.
b. One-hundred twenty (120) VAC control wires: Red.
c. One-hundred twenty (120) VAC externally powered: Yellow.
d. Twenty-four (24) VDC: Blue.
e. Ground: Green.
f. Two (2) conductor shielded cables to have black positive and white negative.

4) To avoid inductive pickup; power wiring or control wiring shall have a maximum possible separation from signal wiring. A practical distance is not less than six inches (6″). If power wiring has to cross the signal wiring, the crossing should be as close to a right angle as possible.
5) Wires shall be run in open slot vinyl wire duct with covers. Wire duct shall be held to the back plate with nylon "push" type rivets. Where it is not practical to use wire duct, wire ties shall be used to bundle the wires together in a neat and professional manner.
6) Where wire is required to flex often (i.e., around door hinges) high strand wire shall be used.
7) All spare I/O points module shall be run to terminal blocks.
8) Each wire shall be identified on both ends of the wire with wraparound shrink type wire markers. The wire marker number shall be a unique number that shall be easily cross referenced with schematic Drawings.

I. Grounding: Two (2) copper ground buses shall be supplied with each enclosure. One (1) ground bus shall be electrically bonded to the panel and shall be used to ground all equipment. The other ground bus shall be an isolated ground bus and shall be used to ground the drain wire of signal wiring. No more than five (5) drain wires shall be jumpered together before being run to the isolated ground bus. The isolated ground bus shall be connected to the non isolated grounded bus with one (1) piece of ten (10) gauge wire.

2.2 MISCELLANEOUS EQUIPMENT

A. System Description: Selector switches, pilot lights, circuit breakers, terminal blocks, heaters, signal isolators, push buttons, fuses, alarm horns, power supplies, contactors and relays shall be provided in and on Contractor supplied panels in accordance with the Drawings. NEMA style devices shall be used.

B. Construction:

1. Circuit Breakers shall be quick make, quick break; thermal magnetic molded case type, individually mounted and identified.
2. Selector Switches shall be thirty and five-tenths (30.5) mm, heavy duty, non-illuminated switches and shall have double break silver contacts. Provide maintained contacts unless otherwise indicated on the Drawings. Provide auxiliary contact blocks where indicated on the Drawings or in the description of operation. Provide legend plates for each switch.
3. Push Buttons shall be black, thirty and five-tenths (30.5) mm, heavy duty, non-illuminated type. Provide double break silver contacts. "Stop" push buttons shall have extended heads. Provide legend plates for each push button.
4. Pilot Lights shall be thirty and five-tenths (30.5) mm, heavy duty, and transformer type. Voltage rating shall be one-hundred twenty (120) volts AC. Provide colored lens; green for "off" or "closed", red for "on" or "open", amber for "fault" blue for "status" and white for "indication" unless otherwise noted on Drawings. Provide legend plates for each pilot light.

a. Spare Parts:

1) Provide one (1) spare lens of each color.
2) Provide four (4) spare bulbs for each pilot light.

5. Fuses: All fuses shall be sized per NEC Code.

a. Spare Parts:

1) Provide one (1) spare fuse for each circuit.

6. Alarm Horns shall be flush mounted as indicated on the Drawings. Voltage rating shall be one-hundred twenty (120) VAC. Provide adjustable three (3) to five (5) minute timer to silence the horn automatically.

7. Terminal Blocks shall be provided in each control enclosure. All terminal blocks shall be rated for six hundred (600) volts AC, and shall be identified with a permanent machine printed marking in accordance with the terminal numbers shown on the panel wiring Drawings. Terminal blocks shall be large enough to accommodate No. 10 AWG wire.

a. Spare Parts:

1) Provide twenty percent (20%) spare terminal blocks in each control panel.

8. Twenty-four (24) Volt DC Power Supplies: Provide DC power supplies as required to power instruments requiring external power. Power supplies shall convert one-hundred twenty (120) VAC, sixty (60) hertz power to DC power. Output, over voltage, and over current protective devices shall be provided with the power supply to protect the instruments from damage due to power supply failure and to protect the power supply from damage due to external failure. Power supplies shall be sized to handle required load plus a minimum of twenty-five percent (25%) for additional future load.

a. Spare Parts:

1) Provide one (1)spare power supply equal to the current rating of the largest power supply provided.

9. General Purpose Relays: Relays shall be designed for multiple switching applications at 120 volts. At a minimum, contact arrangement shall be double pole, double throw (DPDT) with a pilot light. Relay shall plug into an eight or eleven (8 or 11) pin tubular single tier screw terminal.

a. Spare Parts:

1) Provide ten percent (10%) but not less than two (2) of each type.

10. Pneumatic Power Relays: Relays shall be designed for multiple switching of one-quarter to one-third (1/4 to 1/3) HP motors at one-hundred twenty (120) VAC. Coil voltage shall be one-hundred twenty (120) VAC unless otherwise indicated on the Drawings.

a. Spare Parts:

1) Provide ten percent (10%), but not less than one (1) of each type.

11. Contactors shall be used for multi switching of one-half to three-quarters (1/2 to 3/4) HP loads at one-hundred twenty (120) VAC where overload protection is provided elsewhere. Coil voltage shall be one-hundred twenty (120) VAC unless otherwise indicated on the Drawings.

a. Spare Parts:

1) Provide one (1) set of spare contacts for each type of contactor.

12. Signal Isolators in the control panels for four to twenty (4 to 20) mA signals where required to prevent ground loop problems; i.e., four (4) wire transmitter with grounded signal common or loading problems. Isolators shall be modular design to allow easy replacement of the unit. Isolators shall be used if retransmitting non-isolated signals between control panels introduces foreign power sources to local control panels.

a. Spare Parts:

1) Provide four (4) spare isolators of each type.

13. Enclosure Heaters: Provide electric heaters designed for use in enclosures. Unit to consist of a single housing, fan driven, thermostatically controlled unit heaters.

14. Starters: Unless otherwise indicated, provide starters as specified in the Contract Documents.

2.3 MAGNETIC FLOW METERS

A. General Requirements: Provide electromagnetic induction type flow meters in the capacity and type as specified in the Contract Documents.

B. The flow meter shall generate a voltage linearly proportional to flow for full scale velocity settings from two feet to thirty-three feet (2′ to 33′) per second. Accuracy of the pulse output shall be plus or minus two-tenths percent (± 0.2%) of rate and plus or minus one-hundredth percent (± 0.01%) of full scale.

C. The flow meter shall incorporate a high impedance amplifier of 10^{12} ohms or greater, eliminating the need for electrode cleaning systems. The flow meter shall utilize bipolar pulsed DC coil excitation with auto integrated zeroing each half cycle. Manual zero adjustments shall not be required even at start up. Power consumption shall be no more than fifteen (15) VA, independent of flow meter size. Input power required shall be one-hundred twenty (120) VAC, sixty (60) HZ.

D. The flow meter shall be microprocessor based with integral electronics. The electronics shall be interchangeable among all flow meters provided. Remote mounted electronics up to six-hundred fifty (650) feet shall be available where specified. The housing shall be powder coated cast aluminum with a NEMA 4X rating per the Contract Documents.

E. The flow meter analog and pulse outputs shall be independently selectable from one (1) of eight (8) different ranges and shall be selected by DIP switches. The analog output shall be an isolated four to twenty (4 to 20) mA DC into seven hundred (700) ohms load. The pulse output shall be an open collector output with a maximum frequency of four hundred (400) Hz. An open collector status output shall indicate either system or process error, or flow direction. An auxiliary input shall be provided for positive zero return. A low flow cutoff shall be provided which can be turned on or off by one (1) of the internal DIP switches.

F. An eight (8) digit LCD display shall indicate flow rate and total flow. The total value shall be protected by EEPROM during power outages and utilize an overflow counter. The display shall also be capable of indicating an empty pipe condition, error condition, and low flow cutoff.

G. The flow meter body shall be designed for submersion to thirty feet (30′) of water for up to forty-eight (48) hours. The flow meter body shall include grounding and empty pipe electrodes of the same material as the measuring electrodes. Ground probes; rings or straps will not be acceptable.

H. The flow meter shall have FM Class I, Division I approval.

I. The flow meters design shall incorporate the following:

1. ANSI Class 150 flanged ends.
2. Polyurethane liner.
3. Three (3) point standard five-tenths percent (0.5%) calibration.

2.4 PRESSURE TRANSMITTERS

A. General Requirements: Provide pressure transmitter(s) as indicated in the Contract Documents.

B. The pressure transmitter shall be a loop powered, two (2) wire devices requiring an eleven to thirty (11 to 30) VDC power input with a four to twenty (4 to 20) mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus five percent (+ 5%) percent zero point adjustment with no on site calibration required.

C. The transmitter shall be housed in a compact Type 304 stainless steel enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection requiring no additional mounting hardware. The enclosure shall be NEMA 4X per the Contract Document.

D. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to five hundred (500) PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed one thousandths of an inch (0.001”) full scale movements to minimize diaphragm fatigue and the effects of build up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of:

150 PSI for URL of	0.15 PSI
350 PSI for URL of	16.50 PSI
600 PSI for URL of	51.300 PSI
850 PSI for URL of	301.500 PSI

E. The accuracy shall be plus or minus five percent (± 0.5%) of full span including hysteresis and repeatability. The change of zero point between four (4) and plus one-hundred eighty-five degrees (+ 185º) F shall be no more than one and five-tenths percent (1.5%). The change of span between four (4) and plus one hundred eighty-five degrees (+ 185º) F shall be no more than eight-tenths percent (0.8%). Long term stability shall not exceed a fifteen-hundredths percent (0.15%) shift per year.

F. The pressure transmitter shall be ranged zero to fifty (0 to 50) psig; tag name see Contract Document.

G. Provide pressure transmitter with diaphragm protection seal and associated piping as follows:

1. Diaphragm Protection Seal: Provide threaded connection, plain design, removable diaphragm type seal with one-quarter inch (1/4″) NPT flushing connection in lower housing. Each one-quarter inch (1/4″) flushing connection shall include a one-quarter inch (1/4″) screw type plug. Upper and lower housings shall be constructed of Type 316 stainless steel with Type 316 stainless steel hardware per the Contract Document.

    a. Diaphragm: Provide fluoroelastomer diaphragm.
    b. Upper Housing Instrument Connection: Provide connections to accommodate transmitter.
    c. Charging Fluid: Provide fluid recommended by transmitter manufacturer.
    d. Lower Hosing Process Connection: Provide one-half inch (1/2″) NPT process connection.

2. Piping: Provide Schedule 40 (minimum) Type 316 stainless steel nipples, and quarter turn ball valves as required. Fitting size shall be same as diaphragm seal process connection.

    a. Ball Valves: Screwed end type with Type 316 stainless steel with body and trim and TFE packing, thrust washer and seal rings. See Contract Documents for manufacturers.
    b. Mounting: Mount assembly onto process piping with full size tees as indicated on the Drawings.

2.5 DIGITAL INDICATING DISPLAY UNITS

A. General requirements: All suppliers of control panels shall provide digital display units in association with this section.

B. Display units shall be microprocessor based with a six (6) character red LED display.

C. Display shall take as input a four to twenty (4 to 20) mA signal. It shall have scalable linearized retransmission capability for supplying an isolated four to twenty (4 to 20) mA output (max six hundred (600) ohm).

D. The indicator shall display the respective process variable along with the engineering units defined in the respective specification.

E. Indicator shall have LED indications of high, low, deviation, or rate of change alarms.

F. Indicator shall have two (2) relay contact outputs.

G. Indicator shall be one-eighth (1/8) DIN size mounting, one hundred twenty (120) VAC powered, and withstand an ambient temperature of two degrees to fifty-five degrees (2º to 55º) C.

2.6 LIGHTNING AND SURGE PROTECTION UNITS

A. All four to twenty (4 to 20) mA analog signals shall be protected by common mode suppressor diodes.

1. Suppressor diode clamping voltage shall not exceed one and eight-tenths (1.8) times operating voltage.
2. Diodes shall be premounted in double level terminal blocks. Terminal blocks shall be provided with knife disconnects to allow user to monitor and test loops without removing wires, or breaking the loop.
3. All loop power supplies must have the negative lead grounded to allow discharge of over voltages.

B. All data highway communications shall be protected by full common mode, and normal mode protection techniques to include metal oxide varisters, surge suppressor diodes, gas discharge surge suppressors and coil/chokes.

2.7 INPUT/OUTPUT REQUIREMENTS FOR SUBSTATION PCS INTERFACE

A. Digital multifunction meters will be furnished on transformer secondary breakers. Each meter will have an RS 485 port, which, will be required to be interfaced with the PCS. Protocol shall be Modbus. All I/O shall be made available for PCS integration in contiguous blocks.

B. Provide all modules and associated support equipment for interface of multifunction meters to the PCS.

C. Metering information to be sent to the PCS is as follows, for each transformer secondary breaker:

1. Megawatt loading.
2. Megavar loading.
3. Phase A, B and C ampere loading on four-hundred eighty (480) V side of transformer.
4. Phase A B voltage reading on four-hundred eighty (480) V side of transformer.
5. KWH demand.

2.8 SEAL WATER SYSTEM PRESSURE SWITCH

A. General Requirements: Provide pressure switch(s) to maintain system pressure within an adjustable range, and activate an alarm when system pressure falls below an adjustable set pressure.

B. The pressure switch shall have normal wetted parts suitable for air, oil, and water. The housing shall be aluminum rated NEMA 4X. The switching independent elements shall be SPDT with deadband, rated fifteen (15) amps at two-hundred fifty (250) VAC. The primary wetted diaphragm shall be TCP, o-ring wetted shall be per the Contract Document. The pressure port shall be one-quarter inch (1/4″) NPT aluminum. The switch shall have an adjustable range up to one-hundred seventy-five (175) psig.

PART 3 EXECUTION

3.1 INSTALLATION

Install as shown on the Drawings and approved shop drawings and as directed by the manufacturer's representative.

3.2 FIELD TESTING

A. Calibrate and test all instrumentation in the presence of the Engineer.

B. Calibrate all transmitters and receivers to imposed input values representing ten percent (10%), fifty percent (50%) and eighty percent (80%) of full scale. Verify the zero and span calibration of all transmitters. Where totalizers are part of the flow measuring system, calibrate at least three (3) points of imposed inputs covering the range of the units. Use differential heads developed by manometers as inputs in the case of flow meters, measured level or pressure in other cases. Adjust the receiving devices to read the calibrated output of the initial calibration. After placing each measuring system in service, connect a manometer to the test connections provided in the piping and make an actual comparison of the measured variable to readout. Each system must meet the accuracy indicated in the Specifications.

C. Adjust secondary functions, such as alarm actuation and pacing, during initial calibration and demonstrate proper calibration after the system is placed in service. Seal linkage or range adjustments by colored lacquer in the presence of the Engineer immediately following calibration.

D. Conduct process calibration, such as volumetric draw down tests to check flow measurement and totalization and level measurements, on all measuring systems as requested by the Engineer. Provide the necessary gauges and assistance in making these tests.

E. Supply the City with completed calibration sheets based on the parameters of the previously mentioned tests.

F. Fully check entire I/O system in the presence of the Engineer.

G. Supply report for checkout for customer approval that lists exhaustive tests for checkout and associated completion dates.

3.3 DEMOLITION

The Contractor shall obtain all demolition associated loop Drawings from the City and utilize loop Drawings to disconnect all points from the respective power source and at the PCS input or output module for the I/O points defined in this section.

PART 4 MEASUREMENT AND PAYMENT

All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 07 00 BASIC ELECTRICAL MATERIAL AND METHODS

26 07 01.01 ELECTRICAL CONDUIT AND FITTINGS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing electrical conduit and fittings as specified in the Contract Documents or as directed by the Engineer. The requirements of 26 07 01.03, (General Electrical Work and Testing) shall be a part of this Specification.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete shall conform to 03 30 00, (Portland Cement Concrete Structures) Part 2.

B. Metallic Conduit and Fittings shall conform to the Table A.

TABLE A

MATERIAL	SPECIFICATION
Electrical Metallic Tubing	UL 797
Intermediate Metal Conduit	UL 1242
Rigid Metal Conduit	UL 6
Rigid Steel Conduit, Zinc Coated	ANSI C80.1
Metallic Outlet Boxes	UL 514A
Fittings for Conduit and Outlet Boxes	UL 514B

C. Nonmetallic Conduit and Fittings. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Each length shall be stamped or embossed with the grade or type and applicable UL or NEMA designation.

D. Flexible Conduit and Fittings shall conform to the Table B.

TABLE B

MATERIAL	SPECIFICATION
Schedule 40 and 80 Rigid Polyvinyl Chloride (PVC) Conduit	UL 651
Electrical Plastic Tubing (EPT) and Electrical Plastic Conduit (EPC 40 and EPC 80)	NEMA TC 2
Nonmetallic Outlet Boxes, Flush Device Boxes and Covers	UL 514C
Electrical Nonmetallic Conduit (ENC)	NEMA TC 13
PVC Fittings for Use with Rigid PVC Conduit and Tubing	NEMA TC 3
Flexible PVC Coated Conduit	UL 360
Liquid Tight Flexible Nonmetallic Conduit for Detector Sleeves	UL 1660

E. PVC Coated Metallic Conduit and Fittings shall conform to Table C. Unless otherwise specified in the Special Provisions, all conduit and fittings shall be DB 120, shall be rated for wire temperatures of ninety degrees Centigrade (90° C) and shall be encased in a concrete envelope.

TABLE C

MATERIAL	SPECIFICATION
PVC Externally Coated, Galvanized, Rigid Steel Conduit and Electrical Metallic Tubing	NEMA RN 1

PART 3 EXECUTION

3.1 BENDS

Unless otherwise specified in the Contract Documents, changes in direction of conduit shall be accomplished by use of manufactured bends or by field bends. Changes in the direction of conduit shall have an eighteen inch (18″) trade radius.

3.2 CONNECTIONS

Conduit runs shall be made with as few couplings as standard length will permit. Rigid steel conduit connections shall be threaded. Field cut threads of galvanized conduit shall be painted with approved galvanizing repair paint prior to assembly. Nonmetallic conduit shall be connected by a solvent welding process. Fittings for electrical metallic tubing (EMT) conduit shall be watertight cast ferrous compression type.

3.3 CONDUIT TERMINATIONS

Pull boxes or conduit bodies shall be used at conduit terminations. Conduits terminating in cast iron junction boxes shall be threaded into hubs with bonding screws furnished and installed on the interior of the box. Conduits terminating in junction boxes without hubs shall be secured with two (2) lock nuts with an insulated grounding bushing furnished and installed. Conduits terminating at concrete foundations and manholes or hand holes shall be secured as specified in the Contract Documents. All ends of unused conduit shall be capped.

3.4 CLEANING AND CAPPING

Prior to installation of conductors in any run, the conduit shall be checked for cleanliness and all obstructions removed. Each conduit run and all fittings shall be cleaned of all debris by a pull through mandrel type device inserted in the presence of the Engineer. All ends of conduits shall be capped by use of a manufactured cap or plug. Prior to the installation of wiring, manufactured caps or plugs shall be removed and an insulated bonding bushing for galvanized rigid conduit or bell end fittings for PVC conduit installed.

3.5 PULL ROPE

After installation, all conduits, which will be left empty, shall have a pull rope installed. Pull rope shall be made of one-quarter inch (1/4″) nylon material with a minimum tensile strength of four hundred pounds (400 lb.).

3.6 EXPOSED CONDUIT

Exposed conduit runs shall be parallel to, or at right angles to, walls, slabs, girders, etc. Conduit shall be located to minimize accumulation of dirt and to provide accessibility for painting. Conduit shall be attached to steel, concrete, masonry or timber by straps; clamps or hangers of an approved type made of stainless steel or galvanized malleable iron. Spacing of attachments shall be as specified or as directed by the Engineer. When specified, all exposed rigid steel conduit surfaces shall be painted to match the color of adjacent material. All galvanized surfaces shall be prepared as specified in 09 97 13.23, before the application of paint approved by the Engineer.

3.7 EXPANSION JOINTS

Where conduits cross expansion joints in the structure, or where otherwise specified, expansion fittings shall be of the type that assures electrical continuity across the joint.

3.8 BURIED CONDUIT (TRENCHED)

Conduit shall have a minimum cover of twenty-four inches (24″) and shall slope to drain. All underground ductwork shall have magnetically detectable plastic warning tape installed twelve inches (12″) above the duct for the entire length of the duct. Warning tape shall be red for electrical ductwork. The tape shall be three inch (3″) minimum width with warning and identification imprinted in bold black letters “Caution Buried Electrical Line Below” or similar with printed side up. Tape must be unaffected by moisture and other substances contained in the trench or backfill.

3.9 ENCASED CONDUIT (SLOTTED OR TRENCHED)

Conduit to be encased in concrete shall be accurately placed and rigidly held in position so that line and grade are maintained when concrete is placed.

3.10 CONDUIT INSTALLATION UNDER EXISTING PAVED AREAS (BORED)

All conduit placed under existing pavement shall be installed with no disturbance to the existing roadway.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, backfill, conduit encasing concrete, hot mix asphalt, attachments, hangers, paint, bends, connections, fittings, mandrelling, pull ropes and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Electrical Conduit and Fittings and Electrical Conduit and Fittings Attached to Bridges will be measured and paid for at the Contract Unit Price per linear foot measured along the centerline of the conduit from end to end.

C. Electrical hand holes, manholes, pull and junction boxes will be measured and paid for as specified in 26 07 01.02, (Electrical Hand Holes Manholes Pull and Junction Boxes).

D. Electrical conduit and fittings and junction boxes to be constructed into concrete structures will not be measured but the cost will be incidental to the pertinent Concrete Traffic Barrier, Concrete Parapet, or other pertinent Concrete items specified in the Contract Documents.

E. Concrete Foundations will be measured and paid for as specified in 10 14 15.02, (Concrete Foundations for Traffic Signals).

26 07 01.02 ELECTRICAL HAND HOLES, MANHOLES, PULL AND JUNCTION BOXES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing electrical hand holes, manholes, pull and junction boxes as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 HAND HOLES MATERIALS

A. No. 57 Coarse Aggregate shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Concrete Mix No. 2 shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

C. Brick shall conform to M 91, Grade MS.

D. Bolts shall conform to A 276, Type 304.

E. Frames and Covers shall conform to AISC 1020 Steel.

F. Precast Concrete shall conform to M 199.

2.2 MANHOLES MATERIALS

A. No. 57 Coarse Aggregate shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Reinforced Concrete Pipe shall conform to 33 41 00, (Storm Utility Drainage Piping).

C. Cast Iron Manhole. Covers Iron castings shall conform to A 48, Class 30B.

D. Polyethylene (PE) shall conform to the following:

1. PE manholes shall conform to D 1248, Type III, Class C, Category 3, Grade P34. Working Drawings shall be submitted to the Engineer prior to fabrication.
2. Compressive strength shall be determined in conformance with D 2412, modified pipe stiffness test. Pipe stiffness shall be a minimum of twelve (12) psi at five percent (5%) deflection, including joints. Axial compressive strength shall be a minimum of ten thousand (10,000) lb at less than three percent (3%) deflection.
3. PE manholes for storm drains shall be manufactured with an invert bowl, which will not interrupt flow. Manholes for sanitary sewers shall have a factory molded invert for channeled flow.
4. The manufacturer shall furnish certification, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification shall accompany each shipment of PE manholes and shall show actual test results, the quantity of manhole sections, and date of manufacture. Manholes shall be marked with the manufacturer's name and trademark.

E. Precast Concrete shall conform to M 199.

2.3 PULL AND JUNCTION BOXES

A. Steel Plate. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

B. Cast Iron. Iron castings shall conform to A 48, Class 30B.

C. Polymer Concrete Hand Boxes. Shall consist of a fiber glass reinforced polymer concrete box and cover. The box shall be a nominal thirteen inch by twenty-four inch by twenty four inch (13″ X 24″ X 24″) box with an open or closed bottom as specified, design load of twenty-two thousand five-hundred (22,500) lbs and shall conform to ANSI/SCTE 77.

PART 3 EXECUTION

3.1 HAND HOLES AND MANHOLES

A. Hand holes, hand boxes and manholes shall be installed flush to drain with the finished grade. Concrete shall be mixed, placed and tested as specified in 03 30 00, (Portland Cement Concrete Structures). Aggregate drain shall be installed as specified in the Contract Documents. Excavation and backfill shall conform to 34 41 16.06, (Trenching and Backfilling for Traffic Control Devices). When hand holes and manholes are installed in sidewalks, the sidewalk shall be removed and reinstalled to the nearest joint. Spaces between conduit and the hand hole and manhole wall shall be filled or patched with concrete or other sealer as directed by the Engineer.

B. Hand hole and manhole frames shall be set in a mortar or concrete bed as shown in the Contract Documents.

C. Polymer concrete hand boxes shall provide a watertight seal on the hand box and be secured with two pentagonal bolts. They shall be skid resistant and comply with ASTM C 1028. All hand boxes shall be installed on six inches (6″) of pea gravel compacted and extends beyond the box by four inches (4″) on all sides. The box shall be set to finished grade.

D. Hand boxes installed per Contract Drawings shall consist of cement concrete base, a cement cylinder, the frame, the cover and the cement concrete mortar to seal the container. Do not disturb existing conduit lines. Seal the base and all duct entries to prevent loss of material from outside the structure. Each box, except composite hand boxes, shall be installed with a ten foot (10′) long, three-quarters inch (3/4″) copper clad ground rod. An 8 AWG bare copper wire shall be installed from the ground rod and secured to the frame by a ground lug. Composite hand boxes shall not require a grounding rod. The box shall be set to finished grade.

3.2 PULL AND JUNCTION BOXES

Conduit entrance shall be provided with conduit hubs or bosses of sufficient thickness that five full threads of the conduit shall engage the threaded holes in the box.

PART 4 MEASUREMENT AND PAYMENT

Electrical Hand Holes, Manholes, and Pull and Junction Boxes will be measured and paid for at the Contract Unit Price per each unless otherwise specified in the Contract Documents. The payment will be full compensation for all excavation, aggregate drain, concrete, bolts, bricks, pipes, backfill, sealer, frames and covers, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 07 01.03 GENERAL ELECTRICAL WORK AND TESTING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, installing, and testing of all applicable electrical items referred to in Divisions 10, 26 and 34.

PART 2 PRODUCTS

2.1 MATERIALS

All materials and equipment installed as part of the permanent installation shall be new, UL listed or labeled, and shall conform to NEC, NESC, NEMA, IES, and local codes applicable to the area of installation.

PART 3 EXECUTION

3.1 GENERAL

All installations shall conform to NEC, NESC, local utility company requirements and State and local laws and ordinances governing the Work. All electrical Work shall be

accomplished under the direct supervision of a master electrician licensed in the State of Maryland or City. All Work performed under 26 44 00, (Grounding), 26 07 01.01, (Electrical Conduit and Fittings), 26 50 01, (Luminaires and Lamps), 26 27 01, (Electrical Service Equipment), 26 05 23.01, (Facilities Control Transmission Media) except loop wire, 26 07 01.02, (Electrical Hand Holes Manholes Pull and Junction Boxes), 34 41 13.30, (Signal Heads), 34 41 16.08, (Traffic Control Device Cabinets and Equipment), 34 41 16.09, (Push Buttons and Push Button Signs) and this Specification shall be preformed by a journeyman electrician. The Contractor shall obtain and pay for all permits, licenses and inspection fees.

3.2 TESTING

A. The Contractor shall supply all personnel and equipment required to successfully perform the following tests and shall furnish four (4) certified copies of the complete test reports to the Engineer.

B. Not less than thirty (30) days prior to the commencement of each required test, the Contractor shall submit to the Engineer the types, styles or catalog numbers of all testing equipment to be used for the tests. A written certification shall be included stating when the testing equipment was last calibrated by a City approved testing agency. The calibration date shall be within one-hundred eighty (180) days of the date when the tests are to be performed. All tests shall be performed in the presence of the Engineer.

C. Any defects found in the completed installation shall be repaired or replaced immediately to the satisfaction of the Engineer at no additional cost to the City.

1. Ground Resistance Testing. Ground resistance testing shall be conducted using a megger ground tester, using the null balance fall of potential method. Corrected readings greater than twenty-five (25) ohms will not be accepted.
2. Circuit Testing. A circuit test to determine insulation resistance shall be performed on all cables of every circuit except those installed in lighting structures. Cable insulation resistance shall be a minimum of ten (10) megohms at five hundred (500) volts D.C. except loop detector wire and loop detector lead shall have a minimum of one hundred (100) megohms at five hundred (500) volts D.C.
3. The Contractor shall demonstrate in a manner acceptable to the Engineer that all conductors are continuous, free from short circuits and unspecified grounds and that all circuits are properly connected as specified in the Contract Documents.
4. Performance Testing. A performance test using the design power source shall be conducted by the Contractor prior to acceptance. The electrical system, including automatic control equipment, shall be operated for thirty (30) consecutive days without failure. If any component fails, it shall be immediately replaced and the test shall be continued. The Contractor shall record each fault, the method and date of correction of each and the beginning and end of the thirty (30) day test period. If more than five percent (5%) of any component fails during the test, the component shall be replaced and the thirty (30) day test cycle for the entire system shall be restarted.
5. Illumination Testing. An illumination test shall be conducted by the Contractor to determine the illumination characteristics of the roadway lighting installation. The test shall conform to procedures approved by the City.

3.3 TRAFFIC SIGNAL TESTING

A. Testing shall be accomplished without hazard to the traveling public.

B. The Contractor shall maintain all new materials until satisfactorily tested and their operation accepted by the Engineer.

C. All signal heads and signs in place but not in use shall be entirely covered with opaque burlap.

D. After completion, testing and acceptance, any new traffic signal shall be placed on flashing operation for a seventy-two (72) hour period prior to placing the signal on full color operation.

E. Existing full color and flashing signals shall not flash, but shall be kept in operation until the new signal is completed, satisfactorily tested and approved by the Engineer.

F. The Contractor shall remove any STOP signs at new full color signals at the end of the seventy-two (72) hour flashing period. The date and time of removal shall be logged and provided to the Engineer.

G. All signal heads, signs, spans and mast arms, that are not to be put in use, shall be removed upon acceptance by the Engineer and placement of the new traffic control device into operation.

H. New traffic signals, exclusive of signal system interconnect installation, may be placed into operation upon completion of the new traffic signal being satisfactorily tested and accepted by the Engineer. Upon the signal system interconnect installation completion, the signal system interconnect shall also be satisfactorily tested and approved by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

General electrical Work and testing and the as built Drawings will not be measured but the cost will be incidental to the other pertinent items specified in the Contract Documents.

26 07 01.04 ELECTRICAL CONDUIT SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing of single and multiple duct banks, conduit, fittings manholes, recessed extensions, hand boxes, junction and pull boxes, conduit in structures and incidental items necessary to provide for the type, size and location of a conduit system as indicated in the Contract Documents or Standards.

PART 2 PRODUCTS

2.1 MATERIALS

A. Metallic Conduit, Fittings and boxes, refer to Section 26 07 01.

B. Polyvinyl Chloride (PVC) Conduit and Fittings – Refer to section 26 07 01. Unless otherwise specified in the Special Provisions, all conduit and fittings shall be DB 120, shall be rated for wire temperatures of ninety degrees (90° C) and shall be encased in a concrete envelope.

C. Composition of Concrete Mixes – Precast manholes shall be constructed of five thousand (5000) psi. minimum strength concrete at twenty-eight (28) days and shall be designed and manufactured for HS25 44 (MS 18) bridge loading.

1. Encasement – Mix No. 1 in accordance with Section 03 30 00, (Portland Cement Concrete Structures).
2. Cast in place manholes – Mix No. 5 in accordance with Section 03 30 00.
3. Hand box concrete – Mix No. 3 in accordance with Section 03 30 00.
4. Reinforcements – Refer to 03 21 00, (Reinforcing Steel).
5. Joint sealing compound – Refer to Section 32 13 73, (Joint Sealing of Portland Cement Concrete Pavements).
6. Metal casings – Refer to Section 05 12 00, (Structural Metal Framing (metal structures)), ASTM A48 30B.
7. Structural steel – Refer to Section 05 12 00.
8. Steel rod – Pulling irons shall be fabricated from seven-eighths inch (7/8″) diameter A 36 steel rod. The rod shall be galvanized in accordance with ASTM A 123.
9. Furnished material – Hand box frames, covers, concrete cylinder, manhole frames and covers.

PART 3 EXECUTION

3.1 CONSTRUCTION METHODS

A. The dimensions of the concrete encasement and the configuration of the section shall be as specified on the Standards or as indicated in the Contract Documents.

B. Trenches for duct sections shall be excavated, sheeted, shored, pumping and backfilled in accordance with Sections 31 23 33, (Trenching and Backfilling, Point Excavation and Backfill) and 31.23 16.16, (Structural Excavation). The trench width shall not be greater than the width of the concrete encasement, plus sixteen inches (16″).

C. Before any paving is allowed in streets, alleys, sidewalks or similar areas, in place density tests shall be taken and satisfactory results shall be recorded. In areas where the results of such tests show that the backfills are not compacted sufficiently as specified, the Contractor shall at its own expense, correct the condition as directed by the Engineer.

D. Excavation for the installation and encasement of conduit shall be carefully done, sidewalks trimmed and the bottoms of trenches graded to the profile as indicated. All disturbed material in the bottom of the trench shall be compacted before the start of any concrete encasement operations. All backfill, regardless of type, shall be carefully tamped to conform to the requirements of Section 31 24 13, (Embankment and Subgrades). Care shall be taken to assure that the concrete envelope and/or conduit are not damaged during the backfill operation.

E. The Contractor shall remove and dispose of all excavated material and backfill the trenches and area around the manhole and hand boxes with crusher run aggregate CR 6.

F. All duct material used on a project shall be the product of the same manufacturer and bear the same designation, except as may be detailed in the Contract Documents. A thirty degree (30°) chamfer shall be formed or cut on all spigot ends of duct prior to installation. All couplings and fittings shall be of the same material and wall thickness as the duct. All elements of the system to be encased in concrete shall be accurately placed and rigidly held in position so that no vibration from line or grade occurs on the individual ducts or system when concrete is placed. When two (2) different designations of duct are joined, a smooth bore through the transition area shall be assured by using adapters, beveling or other means acceptable to the Engineer. All bends or sweeps specified shall be performed and no duct shall be out of round or distorted more than allowed by manufacturer's specification.

G. The radius of curvature taken at the inner edge of bend shall not be less than thirty-five feet (35′), except as may be otherwise noted on the Contract Documents. Any section of duct cracked, bent, punctured, flattened or distorted, shall be rejected and removed from the project site immediately.

H. The total of all bends between any two (2) manholes, hand boxes, pull boxes or junction boxes shall not exceed one-hundred eighty degrees (180°). All performed bends shall be approved by the Engineer before installation. All joints shall be sealed with a waterproof joint sealing compound recommended by the manufacturer and approved by the Engineer.

I. The duct section shall have a minimum cover of three feet six inches (3′ 6″) under roadways and four feet (4′) under sidewalks. Where it is not possible to adhere to the minimum cover specified because of an underground obstruction, the Engineer shall give approval before the configuration of the duct section or depth of cover is revised.

J. All conduit sections shall be formed using plastic separators of an approved design, furnished and installed by the Contractor. Each duct shall have two inches (2″) of separation from the next nearest duct. When casting the envelope, precaution shall be taken to prevent distortion to or floating out of position of any duct. Standard practices shall be followed in placing concrete at depths in excess of four feet (4′).

K. Occupied Ducts

1. The Work of relocating and reshaping existing occupied duct as shown on the Contract Documents shall be done jointly by the Contractor and cable owner as follows:

   a. Contractor shall excavate and expose the top and side of the existing bank.
   b. Cable owner will remove existing encasement and ducts from around cables occupying them.
   c. Cable owner will install split duct furnished by the Contractor, will relocate or splay the duct bank to a configuration as shown on the Contract Documents and support all occupied duct to suitable grade. A system of support, approved by the cable owner, shall be furnished by the Contractor. The cable owner will Work on the cable occupied duct only. All unoccupied ducts in the duct bank shall be reconstructed by the Contractor.
   d. After the relocated duct section is in place and supported to a suitable grade, the Contractor shall place concrete encasement around the

relocated or newly installed duct section with top, bottom and side thickness of encasement as shown on the Standard Details.

e. After the concrete has cured and the unoccupied duct is tested and found acceptable, the backfill operation may be completed.

f. All requirements of split duct shall be the same as those specified for the proposed duct.

2. Separations will be made only on the written order of the Engineer. Placement of conduit throughout the separation shall be carefully done so the duct will slope uniformly. Crimps at joints or other distortions within the line of duct will not be allowed.

3. When it is found necessary to form a separation in a duct section due to an obstruction, which may or may not indicate on the duct profile, the following procedures shall be followed:

   a. Between the points of intersection within the limit of the separation, the lower section of the splayed duct shall be constructed in its entirety prior to filling the area between the ducts and constructing the upper section of the separation.

   b. Place and support to a suitable grade the lower section of the splayed duct.

   c. Place concrete encasement around the lower splayed duct section with a top, bottom and side thickness of encasement as shown.

   d. Backfill the trench with CR 6 aggregate to an elevation equal to the bottom of the concrete encasement for the upper section of the splayed duct.

   e. Place and support to grade the upper section of splayed duct.

   f. Place concrete encasement around upper splayed duct section with tip, bottom and side thickness of encasement as shown.

   g. After the concrete has cured and the unoccupied ducts tested and found acceptable, the backfill operation can be completed.

L. If Work on a duct section has to be stopped for any reason or is being constructed for future use, the ends of the duct shall be sealed at once with standard caps or plugs.

M. Where existing clay duct conduit lines are to be redirected into new manholes, the existing duct shall be removed for the distance sufficient to provide the following minimum requirements.

1. The line and grade of the existing duct shall be extended by using a square bore adaptor for a minimum of five feet (5′) before any change in alignment is made.
2. Bends or sweeps shall have a radius of not less than twenty feet (20′).
3. Duct entering a manhole shall be at a ninety degree (90°) angle for a minimum of five feet (5′) to the entry wall and properly spaced for the use of bell ends or terminators.
4. Deflection in any joint shall not exceed two degrees (2°).

N. Metallic Conduit, Fittings and Boxes

1. Conduit runs shall be made with as few threaded couplings as standard lengths will permit. All cut lengths shall be made with a hacksaw and reamed clean of fins and burrs.

2. Metal conduit shall have threaded ends, coated with paint and of sufficient length so that they will butt squarely and tightly in the coupling. Long running threads will not be permitted. Metal conduit shall be installed so as to be continuous, water tight and will not trap water.
3. Where metal conduit crosses expansion joints, expansion fittings of an approved type shall be provided. The electrical continuity of all expansion fittings shall be assured by the bonding with a bare number 8 copper wire.
4. Pull boxes shall be used wherever necessary to facilitate the installation of the conductors. Metal conduit entering into cast iron pull boxes or enclosures shall be threaded into hubs on same. Conduit entering into sheet metal boxes or enclosures shall be secured with two (2) lock nuts and the projecting ends shall be equipped with approved insulating bushings. The projecting ends shall be free of sharp edges or burrs.

O. Conduit in Structures

1. Single or multi duct conduit passing through structures may be either galvanized metal or schedule 40 PVC with wire temperature rating of ninety degrees (90°). All exposed conduit runs shall be supported be malleable iron or galvanized steel strips, clamps or hangers of an approved type. Each length of duct shall be supported at a minimum of two (2) locations. Galvanized steel bolts or lag screws shall be used to secure clamps or other devices to the structure. All exposed conduit between structure members shall be supported as specified on seven foot (7′) center or less, and not less than two inches (2″) clear of structural members. Conduit supported as described above shall be secured to prevent rattling and wear.
2. In those structures where expansion devices are incorporated, all ducts shall be provided with an expansion coupling device of an approved type and located in conjunction with the expansion device of the structure. All couplings and/or fittings shall have sufficient clearance from the supporting members so as to provide for the full and independent movement of the structure and duct.
3. Multi duct sections shall have uniform spacing between each duct for circulation of air.

P. Hand Boxes

1. Hand boxes installed at locations shown on the Contracting Documents and/or where directed by the Engineer, shall consist of a concrete base, concrete cylinder, frame, cover and mortar to seal the frame to the cylinder and to seal the conduit to the box and base.
2. Excavation of hand boxes shall be done carefully when working over or adjacent to existing conduit lines. The concrete base must be set to the proper grade. The concrete cylinder of the hand box is to be grouted to the base and all duct entries are to be sealed to prevent the loss of material from outside the structure. The frame is to be attached to the cylinder with mortar and adjusted to meet finished grade. Approved material selected from excavation shall be used for backfill around the hand box.
3. When hand boxes are specified to be installed on an existing conduit system, a specific duct will be assigned for the proposed installation of cable. Prior to the installation of the hand box, the Contractor shall rod the assigned duct. If it is found that the assigned duct is obstructed, the Contractor shall rod other available ducts, as directed by the Engineer, until a clear duct run is found.

4. When a proposed hand box is to be installed on a duct containing existing street lighting and/or traffic signal cable(s) the Contractor is required to install pull ropes per Specification 26 07 01.01, 3.5, (Electrical Conduit and Fittings). Pull rope shall be installed to each of the nearest adjacent manhole, hand box and/or pole base to allow for future continuance of the circuit. The Contractor is to insure the conduit into which the pull ropes are installed are in unobstructed usable condition. The Contractor is responsible for maintaining service continuity of the existing and proposed cable system.
5. The Contractor shall contact Conduit Maintenance Section immediately if the specified duct/conduit is obstructed and the pull rope cannot be installed.

Q. Conduit Manholes

1. All of the applicable parts of Section 03 30 00, (Portland Cement Concrete Structures), shall apply to the Construction of manholes in new and existing conduit systems.
2. Conduit manholes shall be constructed according to type, size and location as designated. On new conduit systems, all manholes shall be constructed before conduit lines are built, in order to assure proper entry of the duct lines into the manhole. The maximum distance between manholes shall not exceed five hundred feet (500′).
3. Proper entry of conduit will be taken to mean the following:

    a. A minimum of twelve inches (12″) from the edge of the nearest duct to the ceiling, floor or wall.
    b. All duct shall enter at right angles to wall section.
    c. All duct shall extend a distance of five feet (5′) normal to the wall of the manhole before any change in direction is made.
    d. Ducts four inches (4″) or larger shall enter into the bottom portion of the manhole. Ducts three inches (3″) shall enter into the top portion of the manhole, unless otherwise shown on the Contract Documents or directed by the Engineer.
    e. When a new manhole is constructed in the roadway, the manhole shall be placed in or near the center of the travel lane to avoid vehicular wheel tracks.

4. Where the enlargement of existing manholes or the Construction of new manholes over existing conduit lines is required, support and protection of all cables shall be provided in a manner acceptable to the cable owner. Shop drawings and scheduling of such operations shall be submitted for approval. Protection shall be provided for all excavated areas.
5. All new and existing ducts entering new manhole walls shall be faced off smooth and free of sharp edges. For all PVC entries, bell ends or terminators shall be used and secured flush with the inside of the wall.
6. The cable owner shall break into existing duct sections where new manholes are to be constructed on existing lines. Relocation of cable in a manhole to expose an area for a new entrance location shall be performed by the cable owner. The Contractor, under the supervision of the Engineer, shall break into existing manhole walls for the entrance of new conduit system. The Contractor shall notify the Conduit Section at least three (3) days in advance of starting any Work on existing conduit systems. Core drilling shall be used when installing new ducts into a concrete manhole. Care shall be taken when an opening is made in an existing

manhole wall for entry of a new conduit system. All duct shall be installed flush with the inside face of the manhole, using bell ends or terminators and all voids or openings in the wall around the ducts shall be filled with concrete.

R. Inspection and Testing

1. A braided nylon line, having a minimal tensile strength of four hundred pounds (400 lbs), shall be installed in each duct.
2. Each duct shall be tested in the presence of the Engineer. A test device made from ridged material not more than one-half inch (1/2″) smaller than the bore of the duct, and a minimum of two feet (2') long, shall be passed through each duct. The device shall be so constructed as to prevent its use through bends whose radius is less than twenty feet (20′). Any duct through which the device cannot be passed shall be repaired by the Contractor to the satisfaction of the Engineer with no additional compensation from the City.
3. All manholes shall be inspected for proper duct entries, terminators, bell ends, pulling in irons, concrete seal around duct, caps or lugs, pull lines and grout seals between the frame and chimney.

    a. The duct line sizing device is to be used as a "go" gauge for new PVC duct and will be used on the basis of a receipt signed by the Contractor.
    b. Use of the device must be observed by the Engineer. Arrangements are to be made at least three (3) days in advance.
    c. Prior to testing, the Contractor shall assure that the bore of all the ducts are clean and clear of fins, burrs or sharp edges and dry.
    d. The Contractor shall supply labor and equipment necessary to gauge the new duct.
    e. If the device meets any resistance within the run of duct, the operation shall stop and the device recovered at its starting point.
    f. Any duct which has resistance to the passing of the device will not be accepted.
    g. Final acceptance of the conduit system will not be made until completion of all the Work in the Contract including completion of cable Work and viability and continuity of cable service acceptance in the specified duct system.

PART 4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Conduit in trenches shall be measured on a linear foot basis. The quantity of each formation specified shall be the number of linear feet of each single or multiway duct section installed, measured in place complete, tested and accepted. Measurement shall be along the center line of the duct section from end to end, or to the inside face of the manhole or structure into which the duct enters.

B. Conduit on structure not monolithically incorporated into the Construction shall be measured on a linear foot basis. Any conduit monolithically incorporated into the Construction of a new structure will not be measured but its cost shall be included in the appropriate structure item. Pull and junction boxes will not be measured.

C. Crusher run aggregate used in filling the additional space for a conduit separation will not be measured.

D. Hand boxes and manholes will be measured on a per/each basis.

E. Recessed extensions will be measured on a per/each basis, except when cast with a poured in place manhole.

4.2 PAYMENT

A. Payment for conduit shall be made at the Contract Unit Price bid per linear foot for each type and size of single or multi way duct completed, tested and accepted.

B. Payment for manholes, precast recessed extensions and hand boxes shall be paid for on a per/each basis. Roding of the existing duct for hand boxes shall be incidental to the cost of hand boxes.

C. The cost of furnishing and installing duct, junction boxes and pull boxes, monolithically incorporated in a structure shall be incidental to the cost of the structure.

D. The price paid for the various items bid to complete a conduit system shall be full compensation for the furnishing and placing of all materials, including duct, preformed bends, duct encasements, terminators, separations, caps, plugs nylon line, crusher run aggregate for separation and backfilling trenches, concrete, reinforcing bars, pull in irons, concrete encasements, removal of portions of existing manholes for recessed extensions, removal and disposal of all excavated material, all preparation, assembly and installation of the materials, connection to manholes, including the facing of existing conduit at the face of the wall, and closing of voids around ducts, supporting and protecting conductors, installing hand boxes, frames and covers, excavation, sheeting and shoring, pumping, forms, hauling and disposal of unsuitable materials, all backfill, compaction, all labor, equipment, tools and incidentals necessary to complete the Work.

26 27 00 LOW VOLTAGE DISTRIBUTION EQUIPMENT

26 27 01 ELECTRICAL SERVICE EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing electrical service equipment necessary for the utility company to connect the electrical power supply as specified in the Contract Documents or as directed by the Engineer and coordinating the connection with the local utility company.

PART 2 PRODUCTS

2.1 MATERIALS

A. Control and Distribution Equipment. Control and distribution equipment enclosures shall be dead front type weatherproof metal enclosed self supporting structures, as specified in

the Contract Documents. Freestanding enclosures shall be fabricated from sheet aluminum and shall be as specified herein. Panel and control equipment cabinets shall be the manufacturer's standard enclosure for the type and application specified.

1. Circuit Breakers. Circuit breakers shall be molded case type having a minimum rating of ten thousand (10,000) amp interrupting capacity (AIC) and be quick make, quick break, thermal magnetic, trip indicating, and have common trip on all multiple breakers with internal tie mechanism. They shall have the current and voltage ratings and number of poles as specified in the Contract Documents and shall be treated to resist fungus and be ambiently compensated for the enclosure and proximity to adjacent breakers. All circuit breakers shall be the bolt in type.
2. Photoelectric Controls. Photoelectric cells are to be installed on all luminaires unless otherwise directed by the Engineer or specified in the Contract Documents. Photoelectric controls shall be solid state, cadmium sulfide type with hermetically sealed silicone rectifier rated one-hundred twenty (120) volts, sixty (60) cycles AC and one thousand (1000) watts maximum load. Built in surge protection shall be provided and a fail safe operating feature shall be included so that the lighting circuits will remain energized in the event the photo control components become inoperative. Nominal operating levels of this control shall turn on at a minimum vertical illumination value of three (3) FC and turn off at a maximum vertical illumination value of six (6) FC. These limitations shall be set by the manufacturer and tolerances of plus or minus twenty percent (20%) for the specified value will be acceptable. Photoelectric controls for luminaires and lighting controls shall be twist lock type. A suitable mounting bracket with locking type receptacle and all other necessary mounting hardware shall be furnished.
3. Contactors and Relays. Contactors of the current ratings and number of poles specified in the Contract Documents shall be held by permanent magnets. They shall be fully rated for all classes of load to six-hundred (600) volts AC and shall have an interrupting rating of six hundred (600) percent of rated current. A hand off automatic selector switch shall be provided in the photoelectric cell circuit. Relays shall be the type, size and contact ratings as specified in the Contract Documents.
4. Panel Boards. Panel boards shall conform to federal Specifications and shall be suitable for operation on the voltage and type service specified in the Contract Documents. They shall be listed and labeled by Underwriters' Laboratories. Panel boards shall be equipped with the number and size circuit breakers specified. Circuit breakers in panel boards shall conform to federal Specifications and shall be bolted to copper busses. Buss ratings shall be as specified.
5. Lightning Arresters. Lightning arresters shall be secondary type, having the specified number of poles and six hundred fifty (0-650) volts RMS. Arresters shall be provided with suitable mounting brackets and all other necessary mounting hardware.
6. Control Power Transformers. Control power transformers shall be the dry type, two (2) windings, of the size and voltage ratings specified in the Contract Documents.
7. Enclosures. Enclosures shall conform to the NEMA type specified. They shall have door clamps, solid neoprene gaskets, welded seams, stainless steel external hardware and continuous hinges with stainless steel pins. Enclosures shall have two (2) weep holes in the bottom and shall be equipped for padlocking.
8. Pad Mounted Enclosures. For ventilation, all cabinets shall be provided with louvered vents in the front door with a removable air filter.

a. Louvers shall satisfy the NEMA Rod Entry Test for 3R rated ventilated enclosure.
b. Filters for all cabinets shall be sixteen inches (16″) long, twelve inches (12″) wide, and one inch (1″) thick. The filter shall cover the vents and be held firmly in place with top and bottom brackets and a spring loaded upper clamp. Exhaust air shall be vented out of the cabinet between the top of the cabinet and the main access door. The exhaust area shall be screened with a screen type material having a maximum hole diameter of one-eighth inch (1/8″).

9. Thermostats and Fans. A thermostatically controlled cooling fan shall be provided for all cabinets. The fan and thermostat shall be rated for one-hundred twenty-five percent (125%) of capacity and they shall be mounted at the top of the cabinet.

a. Thermostats shall be the inline type, single pole, one-hundred twenty (120) volts, and ten (10) amps with a minimum range of forty degrees to eighty degrees (40° to 80°) F.
b. The fan shall have a minimum rated capacity of one hundred (100) CFM airflow and a minimum rated design life of one-hundred thousand (100,000) hours.
c. The thermostat shall be manually adjustable, within a ten degree (10°) range, from seventy degrees to one-hundred sixty degrees (70° to 160°) F.

10. Disconnect Switches and Utility Connections. Disconnect switches shall conform to NEMA standard KS 1-1990. Disconnect switch enclosure shall be Type 4 stainless steel, with external operating handle, enclosure cover interlock and external switch mechanism handle with provisions for securing in both the ON and OFF positions by padlock. The switch mechanism shall be heavy duty design with quick make, quick break, type operations and visible blades.
11. The disconnect switch shall be fusible with integral fuse puller. Single phase disconnect switches shall have two (2) poles with a solid neutral and shall be rated at two-hundred forty (240) VAC. Three (3) phase disconnect switches shall have three (3) poles with a solid neutral and shall be rated at six hundred (600) VAC. The design of the neutral bar may be factory or field installable.
12. Disconnect switch fuse holders for traffic signals, intersection control beacons and intersection lighting operating at one-hundred twenty (120) VAC shall be single phase, sixty (60) amps (fused thirty-five (35) amps).
13. Disconnect switch fuse holders for hazard identification beacons and luminaires mounted on traffic signal structures operating at one-hundred twenty (120) VAC shall be rated single phase, thirty (30) amps (fused twenty (20) amps).
14. Disconnect switches for lighting control cabinets shall have the same number of poles and amperage rating specified in the electrical service equipment item.
15. Disconnect switches for electrical service distribution cabinets shall be two hundred (200) amp, two (2) pole, single phase.

PART 3 EXECUTION

3.1 METERED SERVICE PEDESTAL

A. Metered service pedestals shall consist of a galvanized steel post containing a one hundred (100) amp, two (2) pole, main circuit breaker for service disconnect, branch circuit breakers and integral meter socket.

B. The galvanized steel post shall be designed to be imbedded into the soil a minimum of 18 inches and have a stabilizer shoe. Where specified in the Contract Documents, the post shall be imbedded in concrete. The post and meter socket shall conform to NEMA 3R. Provisions shall be provided to padlock the post closed to protect the circuit breakers and to install a utility company seal to secure the meter.

C. Branch circuit breakers shall consist of a combination of four (4), single pole, twenty (20) amp circuit breakers, and one (1), double pole, twenty (20) amp circuit breaker or as specified in the Contract Documents.

D. Metered service pedestals shall be UL listed “Suitable for Service Equipment” and shall be acceptable to the local utility companies for use as a service connection.

3.2 ELECTRICAL SERVICE DISTRIBUTION CABINET

A. Where an electrical service distribution cabinet is specified, the Contractor shall furnish and install an equipment enclosure, meter socket, disconnect switch, panel boards, transformers, circuit breakers, thermostats, fans, lightning arresters, conduit, wiring and wiring devices, ground fault interrupters and all other equipment necessary to provide a complete functioning electrical service distribution cabinet. All electrical outlets shall be protected by ground fault interrupters (GFI).

3.3 METER SOCKET

Meter sockets shall be provided in either ringed or ringless types as required by the utility company. If a meter is not required, a ringless socket with suitable shunts and a metallic cover plate shall be provided. Hardware for attaching the meter socket to a cabinet, wood post or other structure shall be provided by the Contractor.

3.4 DISCONNECT SWITCH

Disconnect switch shall include all hardware for attaching the disconnect switch to a cabinet, wood post or other structure as specified in the Contract Documents.

3.5 SERVICE CABLE

Electric service cable for traffic signals, intersection control beacons, hazard identification beacons and luminaires mounted on traffic signal structures shall have three (3) individual type THWN wires. Each wire shall be a minimum of nineteen (19) strands. Electric service cable color identification by spray paint, tape, heat shrink tubing or any other post manufacturing method is prohibited.

3.6 UTILITY CONNECTION

A. The Contractor shall arrange a meeting with the Engineer to speak with the various utility company representatives, as specified in the Contract Documents to establish a schedule for utility connections before any control equipment or material is ordered.

B. The Contractor shall not disconnect, de-energize, reconnect, tamper with, or otherwise handle any of the utility company's facilities. The Contractor shall be responsible for the utility service connection to the utility company supplied point of service.

C. The Contractor shall make the necessary arrangements with the utility companies to ensure having needed utilities available at the time of turn on. Any utility energization, connection or disconnection delays will not be a valid reason for any time extension. Difficulties in securing utility company services are to be reported to the Engineer at the earliest possible time.

PART 4 MEASUREMENT AND PAYMENT

A. Engineer will arrange to buy service from the utility company. The payment will be full compensation for the disconnect switch, meter socket, meter, shunts, cover plate, lightning arresters, wiring, conduit risers, wiring trough, conduit nipples and adapters, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Metered Service Pedestal will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for all enclosures, panel boards, circuit breakers, internal wiring, wiring devices, meter sockets, meter, shunts, cover plates, wiring and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

C. Electrical Service Distribution Cabinet will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for all enclosures, disconnect switches, lightning arresters, panel boards, circuit breakers, internal wiring, ground fault interrupter outlets, conduits, wiring devices, meter sockets, meter, shunts, cover plates, wiring and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

D. Meter Socket will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for attachment hardware, meter, shunts, cover plate, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. When an item for meter socket is not included in the Contract Documents, this Work will not be measured, but the cost will be incidental to other pertinent items.

E. Disconnect Switch will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for attachment hardware, fuses, switch and for all material, labor, equipment, tools and incidentals necessary to complete the Work. When an item for this Work is not included in the Contract Documents, this Work will not be measured, but the cost will be incidental to other pertinent items.

F. Underground conduit will be measured and paid for as specified in 26 07 01.01, (Electrical Conduit and Fittings).

G. Service lateral cable will be measured and paid for as specified in 26 05 23.01, (Facilities Control Transmission Media).

H. Concrete foundation will be measured and paid for as specified in 10 14 15.02, (Concrete Foundations for Traffic Signals).

I. Utility connection coordination with the utility company will not be measured, but the cost will be incidental to other pertinent items.

J. All utility company energization, connection or disconnection costs will be the responsibility of the City.

26 27 26 WIRING DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

This Section includes various types of receptacles, connectors, switches, and finish plates.

1.2 SUBMITTALS

A. Submit the following according to the Conditions of the Contract and Specification Sections.

B. Product data for each product specified.

C. Samples of devices and device plates for color selection and evaluation of technical features.

D. Operation and maintenance data for materials and products specified in this section to include in the "Operating and Maintenance Manual" specified in the Contract Document.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for devices and installation.

B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined by OSHA.

1.4 COORDINATION

Cord and Plug Sets: Match cord and plug sets to equipment requirements.

PART 2 PRODUCTS

2.1 WIRING DEVICES

A. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices".

B. Enclosures: NEMA 1 equivalent, except as otherwise indicated.

C. Color: Brown except as otherwise indicated or required by Code.

D. Receptacles, Straight Blade and Locking Type: Except as otherwise indicated, comply with Federal Specifications and heavy duty grade of UL Standard 498, Electrical Attachment Plugs and Receptacles. Provide NRTL labeling of devices to verify these compliances.

E. Receptacles, Straight Blade, Special Features: Comply with the basic requirements specified above for straight blade receptacles of the class and type indicated, and with the following additional requirements:

1. Ground Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed through type, with integral NEMA 5 20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Design units for installation in a two and three-quarters inches (2-3/4″) (seventy (70) mm) deep outlet box without an adapter.

F. Receptacles, Industrial Heavy Duty: Conform to NEMA Standard PK 4 "Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use."

G. Receptacles in Hazardous (Classified) Locations: Comply with NEMA Standard FB 11 "Plugs, Receptacles, and Connectors of the Pin and Sleeve type for Hazardous Locations" and UL Standard 1010 "Receptacle Plug Combinations for use in Hazardous (Classified) Locations."

H. Pendant Cord/Connector Devices: Matching, locking type, plug and receptacle body connector, NEMA L5 20P, L5 20R, and heavy duty grade.

1. Bodies: Nylon with screw open cable gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire strand and matched to cable diameter and with attachment provision designed for the corresponding connector.

I. Cord and Plug Sets: Match voltage and current ratings and number of conductors to requirements of the equipment being connected.

1. Cord: Rubber insulated, stranded copper conductors, with type SOW A jacket. Grounding conductor has green insulation. Ampacity is equipment rating plus 30 percent minimum.
2. Plug: Male configuration with nylon body and integral cable clamping jaws. Match to cord and to receptacle type intended for connection.

J. Snap Switches: Quiet type AC switches, NRTL listed and labeled as complying with UL Standard 20, "General Use Snap Switches," and with federal Specifications.

K. Snap Switches in Hazardous (Classified) Locations: Comply with UL Standard 894, "Switches for Use in Hazardous (Classified) Locations."

L. Dimmer Switches: Modular full wave solid state units with integral, quiet on off switches, and audible and electromagnetic noise filters.

1. Wattage rating exceeds connected load by thirty percent (30%) minimum, except as otherwise indicated.
2. Control: Continuously adjustable slide, toggle or rotary knob. Single pole or three (3) way switch to suit connections.
3. Incandescent Lamp Dimmers: Modular dimmer switches for incandescent fixtures; switch poles and wattage as otherwise indicated, one-hundred twenty (120) V,

sixty (60) Hz with continuously adjustable rotary knob, toggle, or slide, single pole with soft tap or other quiet switch. Equipped with electromagnetic filter to eliminate noise, RF and TV interference, and five inch (5″) (one-hundred twenty-seven (127) mm) wire connecting leads.

4. Fluorescent Lamp Dimmers: Modular dimmer switches compatible with dimmer ballasts. Trim potentiometer adjusts low end dimming. Dimmer ballast combination is capable of consistent dimming to a maximum of ten percent (10%) of full brightness.

M. Telephone Jack: Eight (8) position, modular, latching plug type, flush in face of wall plate.

N. Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:

1. Color: Matches wiring device except as otherwise indicated.
2. Plate Securing Screws: Metal with heads colored to match plate finish.
3. Material: Four-hundredths inch (0.04″) thick (one (1) mm thick), type 302, satin finished stainless steel, except as otherwise indicated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi gang wall plates.

D. Protect devices and assemblies during painting.

E. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit the indicated arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with "Electrical Identification."

1. Switches: Where three (3) or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved on wall plate.
2. Receptacles: Identify the panel board and circuit number from which served. Use machine printed, pressure sensitive, abrasion resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Testing: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least six (6) times.

B. Test ground fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.

C. Replace damaged or defective components.

3.4 CLEANING

General: Internally clean devices, device outlet boxes, and enclosures, replace stained or improperly painted wall plates or devices.

PART 4 MEASUREMENT AND PAYMENT

All items will be paid for at the Contract lump sum price. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 44 00 GROUNDING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing grounding systems as specified in the Contract Documents or as directed by the Engineer. The grounding system shall conform to the latest editions of the National Electrical Code (NEC) and the National Electric Safety Code (NESC).

PART 2 PRODUCTS

2.1 MATERIALS

Ground Wire and Rods: Ground wire shall be bare medium drawn copper. Ground wire installed underground shall be of the size and configuration (solid or stranded) as shown in the Contract Documents. Ground rods shall be seventy-five-tenths inch (0.75″) diameter, a minimum of ten feet (10′) in length, with a steel core and copper jacket.

PART 3 EXECUTION

3.1 EQUIPMENT GROUNDING SYSTEM

Equipment grounding system shall consist of the ground wire, electrically continuous metallic conduit system, grounding conductors, ground rods and terminations. Every item of equipment served by the electrical system shall be bonded to the equipment grounding system.

3.2 GROUNDING CONDUCTORS

Grounding conductors shall be the size and type specified in the Contract Documents.

3.3 GROUND RODS

A. Ground rods shall be installed as specified in the Contract Documents. Maximum acceptable earth resistance value shall be twenty-five (25) ohms. Ground resistance of each rod shall be measured before connecting the rod to the grounding conductor. If the measured resistance exceeds twenty-five (25) ohms, a ten feet (10′) extension rod shall be exothermically welded to the top of the first rod, then driven to its full depth. Earth resistance shall again be measured, and if it still exceeds twenty-five (25) ohms, the Engineer shall be contacted for instructions.

B. Where rock is encountered and acceptable earth grounds cannot be accomplished by driving as described above, the Engineer may direct the use of a grounding grid utilizing direct buried rods exothermically welded end to end to bond lighting standards and structures in continuous series to some point where an acceptable earth ground can be obtained.

3.4 CONTINUITY

Continuity of the equipment grounding system shall be maintained throughout the project.

3.5 TERMINATIONS

Connection to equipment grounding system shall be made with suitable lugs at all grounding bushings specified in 26 07 01.01, and at the ground lugs in lighting structure access holes or in a breakaway base. Connections to ground rods shall be as specified in the Contract Documents. Connections to neutral grounding systems shall be made with lugs, as specified in 26 07 01.01.

3.6 TESTING

Refer to 26 07 01.03.

PART 4 MEASUREMENT AND PAYMENT

A. Ground Rods will be measured and paid for at the Contract Unit Price per each ten foot (10′) length. The payment will be full compensation for all rods, lugs, driving rods, welding, excavation, backfill, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Ground Wire will be measured and paid for as specified in 26 05 19, Part 4.

26 50 00 LIGHTING

26 50 01 LUMINAIRES AND LAMPS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing luminaires and lamps. The requirements of 26 07 01.03, (General Electrical Work and Testing) shall be a part of this Specification.

PART 2 PRODUCTS

2.1 MATERIALS

A. Luminaires and Lamps. The luminaire shall be a complete lighting device consisting of a housing, support clamp, reflector, refractor or flat lens, socket, lamp, integral ballast, terminal block, associated hardware and necessary wiring. All parts of the luminaire shall incorporate the latest ratings and design improvements. Luminaires shall incorporate individual photoelectric cells unless otherwise directed by the Engineer or specified in the Contract Documents. Exposed hardware shall be tamperproof stainless steel.

1. Luminaire Construction

a. The bracket arm mounted luminaire housing shall be cast aluminum with natural finish. The housing shall contain and support the reflector, refractor or flat lens, socket, ballast, terminal block and support clamp. Provisions shall be made for leveling and adjusting the luminaire to the specified transverse and longitudinal position to the roadway. The refractor or flat lens retaining ring shall be securely latched with an operable hinge made from noncorrodible material. The reflector shall be of specular polished alzak aluminum or equivalent aluminum reflective surface. It shall be held firmly in the housing but easily removed without the use of special tools. Silicone rubber, ethylene propylene terpolymer, Dacron felt gaskets, or other gasketing materials as approved by the Engineer, shall seal the optical assembly at the socket entry and between the refractor and reflector to make a dust tight optical system. The reflector shall be clean and free from scratches. Glass for the refractor or flat lens shall be heat resistant, borosilicate glass and shall be free of imperfections. The optical system of the luminaire shall clearly indicate the street side and curbside. The socket shall be a mogul screw shell with large center contact spring providing a firm contact with the lamp base. The socket shall have lamp grips to prevent the lamp from loosening. The shell shall be of the skeleton type or shrouded in porcelain. The contacts shall be identifiable. Socket extension adapters will be permitted for special applications when directed by the Engineer. Luminaires providing various ANSI/IES type of distribution by socket adjustment shall also include a means of identification to associate each lamp position with each distribution type. The socket adjustment shall provide positive positioning by means of index holes, lugs or notches. Slots with infinite settings are prohibited. The ballast shall be a high power factor, auto regulator type, capable of operating from a multiple circuit and shall operate a high intensity discharge lamp of the type, wattage and voltage specified. Multi tap ballasts shall be provided where supply voltage is two-hundred seventy-seven (277) volts or

less. The ballast shall start the lamp at temperatures as low as minus twenty degrees (− 20°) C and shall deliver rated lamp current at circuit voltage variation of plus or minus ten percent (± 10%). The primary power factor shall not be less than ninety percent (90%) with normal secondary load. The ballast assembly shall be provided with plug in connectors and installed on a hinged door to permit ready interchange of ballast. Glare shields shall be provided on luminaires where specified in the Contract Documents or as directed by the Engineer. The glare shield shall cut off the upward component of light but shall not reduce the total output of the luminaire more than three percent (3%).

b. Bridge underpass luminaires shall be a complete lighting device, consisting of a cast aluminum housing, a door with cast aluminum frame and thermal shock resistant glass refractor attached to the frame with a stainless steel latch, hinges and retaining chain, a specular polished alzak aluminum reflector, a shrouded adjustable porcelain socket and an integral ballast as specified above. The refractor and reflector shall direct all useful light well below all normal driver viewing angles to assure that glare will be at a minimum.

c. Sign lighting luminaires shall be mercury vapor. A mercury vapor luminaire shall consist of a luminaire housing and a refractor/door assembly constructed of die cast aluminum. The refractor shall be a single piece molded thermal shock resistant borosilicate glass convex lens with discrete prism patterns. The refractor shall be permanently sealed to the door assembly with silicone adhesive around its perimeter. The reflector shall be a single piece die-form of sheet aluminum alloy 3002 or as approved by the Engineer, processed to Alcoa Class SI alzak finish. A heavy duty mogul lamp holder shall be securely mounted to the reflector with a galvanized steel bracket. The refractor/door assembly shall be nonpermanently sealed to the luminaire housing and reflector assembly with a single piece neoprene gasket to effectively seal the luminaire and locked in place by stainless steel spring loaded latches. The refractor/door assembly shall open and be held captive by double pivot internally mounted stainless steel hinges and it shall be removable.

d. Weep holes shall be provided in the bottom of the housing in the lowest area of the luminaire as normally mounted.

e. The sign lighting luminaire shall be designed to properly illuminate the sign with the lamp source type and size as specified in the Contract Documents. The Contractor shall submit for the approval of the Engineer, Working Drawings showing locations and aiming angles of luminaires in relation to each of the signs of the various sizes.

2. Lamps shall be provided for luminaires of the type and wattage specified in the Contract Documents. Lamps shall be first line, high quality and will be as approved by the Engineer. Lamp wattage, horizontal or vertical initial lumens, rated lamp life, and percent of initial lamp lumens at end of rated lamp life shall be as follows:

TYPE	WATTS	INITIAL LUMENS	RATED LIFE (10 hr/start)	PERCENT INITIAL LUMENS
Deluxe Mercury	175	8600	24000	74
Deluxe Mercury	250	12100	24000	74
Deluxe Mercury	400	22500	24000	60
H.P. Sodium	100	9500	20000	74
H.P. Sodium	150	16000	24000	74
H.P. Sodium	200	22000	24000	72
H.P. Sodium	250	30000	24000	73
H.P. Sodium	310	37000	24000	72
H.P. Sodium	400	50000	24000	73
Metal Halide	250	20000	10000	80
Metal Halide	400	40000	15000	80

B. Photoelectric Controls

1. All luminaires shall be installed with photoelectric cells unless otherwise directed by the Engineer or specified in the Contract Documents.
2. Photoelectric controls shall be solid state, cadmium sulfide type with hermetically sealed silicone rectifier rated one-hundred twenty (120) volts, sixty (60) cycles AC and one thousand (1000) watts maximum load. Built in surge protection shall be provided and a fail safe operating feature shall be included so that the lighting circuits will remain energized in the event the photo control components become inoperative. Nominal operating levels of this control shall turn on at a minimum vertical illumination value of three (3) FC and turn off at a maximum vertical illumination value of six (6) FC. These limitations shall be set by the manufacturer and tolerances of plus or minus twenty percent (± 20%) for the specified value will be acceptable. Photoelectric controls for luminaires and lighting controls shall be twist lock type. A suitable mounting bracket with locking type receptacle and all other necessary mounting hardware shall be furnished. Provide delay in excess of fifteen (15) seconds to prevent unit from functioning due to sudden brilliant light as from vehicles, lightning, etc. The design of the photocell control shall be such that the unit may face any direction without seriously effecting turn on or reducing the life of the unit. Photo controls shall operate in a temperature range of minus fifty degrees to plus sixty degrees (−50° to +60°) C. Control shall be preset at the factory for "ON" at approximately two (2) fc.

PART 3 EXECUTION

3.1 ARM MOUNTED LUMINAIRES

Luminaire mounting shall be installed on the respective structures and adjusted as specified in the Contract Documents. The socket positions shall be adjusted to provide the required photometric performance. The luminaire shall include an individual photocell unless otherwise directed by the Engineer or specified in the Contract Documents.

3.2 BRIDGE UNDERPASS LUMINAIRES

Bridge underpass luminaires shall be installed on structures as specified in the Contract Documents. Luminaires shall be connected and lamp sockets adjusted where necessary as specified in the manufacturer's recommendations.

3.3 CLEANING

After installation has been completed and prior to the thirty (30) days performance test, refractors and reflectors shall be cleaned with a product approved by the manufacturer.

3.4 INSTALLATION

A. All luminaires and lamps of the proper type, wattage and voltage rating shall be furnished in their original cartons and firmly installed on the pole as specified in the Contract Documents or in conformance with the manufacturer's written instructions and recognized industry practices; to ensure the fixtures comply with the requirements and serve the intended purposes. Completed Work is to conform to NEMA standards and requirements of the National Electrical Code pertaining to the installation of lighting fixtures and with applicable NECA "Standard of Installation." Lamp materials and ballasts shall comply with ANSI with UL listing and labels.

B. Handle lighting fixtures carefully to prevent breakage, denting or scoring the finish. Do not install damaged lighting fixtures. Replace and return damaged fixtures to the lighting manufacturer.

C. Store lighting fixtures in a clean, dry space, in original cartons and protected from dirt, physical damage, weather and Construction traffic.

D. Component to component wiring within the luminaire shall carry no more than eighty percent (80%) of the rated current and shall be listed by UL for use at six hundred (600) VAC at one-hundred five degree (105°) C or greater. Field wiring terminals shall accept service leads up to AWG No. 6. Terminals and plug disconnects shall be listed by UL. Minimum wire size used in fixtures shall be No. 12 copper AWG. All wire connections shall be vibration proof type, crimp or solder connections are not acceptable. Wiring shall be furnished complete down to the hand hole with a minimum four foot (4') pigtail on each wire at the base of the pole for the installation by Baltimore Gas and Electric of the required fuse kit. Black colored wire shall be hot and white colored wire is to be neutral.

E. Required H.E.R. fuse kits shall be accessible from the hand hole. Fuse kits for new lighting fixtures shall be furnished and installed by Baltimore Gas and Electric and relocated lighting fixtures fuse kits shall be disconnected and reinstalled after relocation by Baltimore Gas and Electric, unless otherwise directed by the Engineer or specified in the Contract Documents.

F. Ballasts which have CBM/ETL certification.

G. All hardware shall be stainless steel 316 grade or better with all exposed hardware of a tamperproof type.

3.5 SPECIFIC LUMINAIRES

A. Cobra Head Luminaires

1. Manufacturer shall be G.E. and produce I.E.S. type III distribution and be of the wattage specified in the plans.
2. All lamps shall be clear high pressure sodium vapor lamps and shall have a heat/impact resistant glass prismatic refractor with optical doors having external quick release stainless steel ball latch requiring no tools to operate. Provide a gasket between the reflector and the refractor. Optical assembly shall contain formed aluminum reflector with a chemically bonded lightweight nonbreakable glass finish on inside and exterior surfaces providing corrosion resistance, durability and ease of cleaning
3. Provide with a detachable ballast door and quick disconnects and a multi tap regulator ballast. Provide all luminaries with a prewired no tool locking type receptacle for photoelectric control, a photocell and a two inch (2″) slip fitter. Photocell shall be wired to the ballast or ballast terminal block.
4. Luminaire and ballast shall be from the same manufacturer. Ballast assembly shall be all components to be mounted on the door and easily removable and replaceable through the use of quick disconnect plugs. Ballast shall be prewired to the lamp holder receptacle with one (1) ballast operating one (1) HPS lamp requiring only of power leads to the terminal board. The plug in igniter for HPS lamps shall be removable without use of tools. Each ballast shall be of a separate component type capable of providing reliable lamp starting down to minus twenty degrees (− 20º) C. Ballast shall be utility grade having a ten (10) kv B.I.L. rating or higher.
5. All items are to be shipped as one (1) complete unit and shall include arms and all wiring to the hand hole and shall be tested to the satisfaction of the Engineer. Required fuse kits shall be furnished and installed by others, unless otherwise directed by the Engineer or specified in the Contract Documents.
6. The luminaire shall include die cast aluminum top handling optical door with refractor, hinge and removable door. The pole base shall contain four (4) bolts that do not pass through the housing, but tighten from below with the door in the dropped position. The one (1) piece pipe clamp shall be capable of adapting to one and one-quarter inch (1-1/4″) through two inch (2″) pipe bracket without rearranging the clamp or bolts and shall be adjustable plus or minus five degrees (± 5°) from horizontal.
7. Auxiliary equipment shall be securely attached to utilized tray with vibration proof fasteners and quick disconnects to allow the equipment to be removed, replaced or upgraded without the use of tools.
8. A separate polarized quick disconnect plug shall disconnect all conductors from power source.
9. Approval must be obtained prior to the Contractor placing the order for any of these items.

B. Otterbein Luminaires

1. Vent assembly to be spun aluminum with integrally mounted twist lock three (3) prong photocell receptacle. Vent assembly to be secured with two (2) stainless steel tamperproof screws. Photocell to be provided by Contractor. Finish shall be black as specified.
2. Cage assembly to be cast aluminum alloy 319 with nonferrous fasteners. Roof to be hinged with stainless steel hinge pins and secured with tamperproof stainless steel fasteners. Bottom cage secured to ballast housing by integrally mounted one-

half an inch (1/2″) twenty (20) stainless steel screws. Finish shall be black as specified.

3. Ballast housing to be cast aluminum alloy 319 with minimum wall thickness of one-hundred twenty-five-thousandths (.125). Post fitter shall slip three inches (3″) O.D. post top tenon. Ballast housing will have slide out shelf on which ballast components are mounted. Provide quick disconnects and safety chain to prevent accidental dropping. Housing secured to post by three (3), one-quarter inch (1/4″) twenty (20) tamperproof stainless steel set screws. Finish shall be black as specified.
4. Panels shall be minimum one-hundred twenty-five-thousandths (.125) thickness clear Lexan secured with two (2) glass clips at the top and cage lugs at bottom. Two (2) cage corner wire covers conceal wiring.
5. Lamping: Mogul base horizontally mounted porcelain socket attached to type 3 cut off reflector system. Reflector system shall have photometrics based on use of one-hundred fifty (150) watt HPS lamp rated at sixteen thousand (16,000) initial lumens and the Special Provisions detail titled “Isolux Diagram for 12′ Mounting”. Reflector is held in place with clips and a quick disconnect is supplied for ease of removal. Decorative three (3) cluster optic assembly located in base of cage with brass holder with reflective top surface. Ballast shall be one-hundred fifty (150) watt, HPF, Quadri volt and operate one (1) one-hundred fifty (150) watt HPS lamp having normal lamp voltage of fifty-five (55) volts and be multi tapped suitable for use on primary voltage one-hundred twenty (120) volts or two-hundred forty (240) volts. All wiring will be one-hundred fifty degree (150º) C rated and system components shall be UL listed.
6. Wiring to luminaire to be furnished complete and installed down to the hand hole with a minimum four foot (4′) pigtail on each wire at the base of the pole for the installation of the required fuse kit. Black colored wire shall be hot and white colored wire is to be neutral. All wiring within the pole shall be #12 AWG. Required HEB fuse kit shall be furnished and installed by others.
7. Finish shall be flat powder coat in designated color(s), coated with polymer powder resin which is then heat treated at high temperature. Finish to be laboratory tested for weatherability and fade resistance in accordance with ASTMB117 64 and ANSI/ASTMG53 77 Test Specifications.
8. Special Provisions.

    a. The total coefficient of utilization (CU) shall exceed four-hundred seventy-nine-thousandths (.479).
    b. The total street side CU shall exceed two-hundred eighty-five-thousandths (.285).
    c. The street side CU at a street width of two (2) mounting heights (MH) shall exceed twenty-two-hundredths (.22).
    d. The reflector shall have a sharp cut off and project less than three percent (3%) of the total light output beyond the three and seventy-five-hundredths (3.75) MH lateral a longitudinal distance lines.
    e. The total house side CU shall not exceed one-hundred ninety-four-thousandths (.194) and less then seven point zero percent (7.0%) of that output shall be projected beyond one (1) MH to the house die (house side spill control).
    f. The sixteen hundredths (.16) iso-footcandle line shall meet the curb line beyond the two and ninety-five-hundredths (2.95) MH longitudinal distance line.

g. The six-tenths (.6) iso-footcandle line shall fall beyond the street side area encompassed by the one and eighty-five-hundredths (1.85) MH lateral and longitudinal distance lines.

C. Homeland Luminaires

1. Finial assembly shall be cast aluminum alloy concealing integrally mounted twist lock, three (3) prong photocell receptacles with quick disconnect complete with photocell. Finial shall be secured with three (3) tamperproof stainless steel set screws.
2. Cage assembly shall be one (1) piece aluminum cast Construction with minimum two-hundred fifty-thousandths (.250) wall thickness, include heat sink to hold socket. Top shall be one (1) piece cast aluminum with integral cast hinge. All fasteners shall be stainless steel. A stainless steel hinge pin and safety chain shall be provided to prevent top from opening more than one-hundred thirty-five degrees (135°) from horizontal.
3. Cage shall be provided with six (6) molded and mechanically secured optical efficient polycarbonate refractive panels of one-hundred twenty-five-thousandths (.125) thickness. House side shield shall combine with these panels to produce photometrics as stated above in 26 50 01, 3.5, B 8, a. through g.
4. Ballast shall be one-hundred fifty (150) watt, HPF and operate one (1) one-hundred fifty (150) watt HPS lamp having normal lamp voltage of fifty-five (55) volts and be multi tapped suitable for use on primary voltage one-hundred twenty (120) volts or two hundred forty (240) volts with a mogul base 4KV rated socket. All wiring will be one-hundred fifty degree (150°) C rated and system components shall be UL listed.
5. Finish is same as Otterbein luminaires.
6. Warranty to be three (3) years in length and be supplied with bid.

D. Post Top Luminaires

1. Manufacturer shall be G.E., PM 17. The fixture shall be a one-hundred fifty (150) watt HPS lamp with a heavy duty mogul base. The base socket shall be provided with nickel plated tempered brass split shell lamp grips and a free floating spring loaded center contact. The optical assembly shall have an acrylic prismatic refractor.
2. The luminaire shall be provided with a mag-reg ballast. The plug in type igniter and ballast shall be prewired to the lamp socket requiring connection to power feeds only. The ballast shall be in full compliance with Specifications required by the manufacturer.
3. The luminaire shall include a die-cast aluminum ballast housing with a hinge and gasketed canopy having a stainless steel latch for no tool relamping. Also include stainless steel hardware and terminal board. A prewired photoelectric receptacle and photocell shall be provided with each luminaire.
3. The luminaire shall provide a medium, semi cut off type III IES distribution and be UL listed.
4. All exposed metal parts are to be painted grey.
5. After the installation has been completed the Contractor shall perform an operational test as directed by the Engineer. Contractor is to provide power to the installation for the test. The installation shall be continuously tested from sunset to sunrise for a period of ten (10) consecutive days without interruption or failure. If a ballast or lamp should fail, it shall be immediately replaced and the test will be

restarted. After the installation has been approved, the City of Baltimore will perform the permanent electrical connection to the City power system.

3.6 MEASUREMENT AND PAYMENT

Luminaires will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for luminaires, lamps, ballast, photocell, mounting hardware, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 50 02 LIGHTING – CONDUITS, FITTINGS AND BOXES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing electrical conduit and fittings necessary to provide for future lighting or operation of structures, as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials for conduits, fittings and boxes and installation of same shall conform to the requirements of the following:

1. Metallic Conduits: National Electrical Code and UL.
2. PVC Conduits: National Electrical Code and UL.
3. Junction Boxes: National Electrical Code and UL.

PART 3 EXECUTION

3.1 FITTINGS

All conduit fittings shall be galvanized steel. Couplings shall be securely tightened to provide a good electrical and mechanical connection throughout the entire length of the conduit run. When a standard coupling cannot be used, a threaded union coupling approved by the Engineer shall be used. Conduits, fittings and boxes shall be stored under cover and above ground.

3.2 BENDS

Unless otherwise specified in the Contract Documents, changes in direction of conduit shall be accomplished by use of manufactured bends or by field bends. Conduit shall be bent without crimping or flattening and shall have a radius of not less than ten (10) times the inside diameter of the conduit.

3.3 CONNECTIONS

Conduit runs shall be made with as few couplings as standard length will permit. Rigid steel conduit connections shall be threaded. Field cut threads of galvanized conduit shall be painted with approved galvanizing repair paint prior to assembly. Nonmetallic conduit shall be connected by a solvent welding process. Fittings for electrical metallic tubing (EMT) conduit shall be watertight cast ferrous compression type.

3.4 CONDUIT TERMINATIONS

Pull boxes or conduit bodies shall be used at conduit terminations. Conduits terminating in cast iron junction boxes shall be threaded into hubs with bonding screws furnished and installed on the interior of the box. Conduits terminating in junction boxes without hubs shall be secured with two (2) lock nuts with an insulated grounding bushing furnished and installed. Conduits terminating at concrete foundations and manholes or hand holes shall be secured as specified in the Contract Documents. All ends of unused conduit shall be capped. Spare conduit stubs from foundations shall extend at least six inches (6″) from the face and at least fourteen inches (14″) below the top of foundation and shall be capped on each end. The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made so that the ends will come together for the full circumference thereof. Slip joints or running threads shall not be used for coupling conduits.

3.5 CLEANING AND CAPPING

Prior to installation of conductors in any run, the conduit shall be checked for cleanliness and all obstructions removed. Each conduit run and all fittings shall be cleaned of all debris by a pull through mandrel type device inserted in the presence of the Engineer. All ends of conduits shall be capped by use of a manufactured cap or plug. Prior to the installation of wiring, manufactured caps or plugs shall be removed and an insulated bonding bushing for galvanized rigid conduit, or bell end fittings for PVC conduit installed. Backfilling shall be completed in two (2) layers with the first layer being placed simultaneously with the drain, holding the drain flush against the side of the pavement. Backfill material shall be compacted using a vibratory shoe compactor.

3.6 PULL ROPE

After installation, all conduits, which will be left empty, shall have a one-quarter inch (1/4″) nylon pull rope with a minimum tensile strength of four hundred pounds (400 lbs.) installed. At least two feet (2′) of pull rope shall be extended beyond each end of the conduit runs and secured. All conduit ends shall be capped until the pulling of conductors is started. When caps are removed, the ends of metallic type conduit shall be provided with threaded conduit bushings.

3.7 EXPOSED CONDUIT

Exposed conduit runs shall be parallel to, or at right angles to, walls, slabs, girders, etc. Conduit shall be located to minimize accumulation of dirt and to provide accessibility for painting. Conduit shall be attached to steel, concrete, masonry or timber by straps; clamps or hangers of an approved type made of stainless steel or galvanized malleable iron. Spacing of attachments shall not be more than five feet (5′) apart or as specified or as directed by the Engineer. When specified, all exposed rigid steel conduit surfaces

shall be painted to match the color of adjacent material. All galvanized surfaces shall be prepared before the application of paint approved by the Engineer.

3.8 EXPANSION JOINTS

Where conduits cross expansion joints in the structure, or where otherwise specified, expansion fittings shall be of the type that assures electrical continuity across the joint. Each expansion fitting shall be provided with a No. 8 AWG copper bonding jumper.

3.9 BURIED CONDUIT (TRENCHED)

Conduit shall be placed to a depth of not less than thirty inches (30″) nor more than sixty inches (60″) below the flowline grade, except that conduit placed behind a curb shall not be less than fourteen inches (14″) nor more than thirty-six inches (36″) below top of curb and conduit placed under railroad tracks shall not be less than thirty-six inches (36″) nor more than sixty inches (60″) below bottom of ties. Buried conduit shall slope to drain and shall be placed directly behind the curb. However, when there are obstructions such as foundations, pull boxes, water meter vaults, etc., the conduit may be placed further behind the curb. In no case shall the conduit be placed more than thirty-six inches (36″) behind the curb unless otherwise approved by the Engineer. Conduit may be laid on top of the existing pavement within curbed medians being constructed on top of said pavement. Conduit laid in open trenches shall not be covered nor shall any trench or inspection hole be backfilled until the Engineer has approved the installation. Detector, telephone interconnections or street lighting conduit shall be one inch (1″) nominal size unless otherwise specified. Direct interconnection, utility service or traffic signal conduits shall be two inch (2″) nominal size unless otherwise specified. The Contractor may, at its expense, use conduit of a larger size than that shown or specified, provided the larger size is used for the entire length of the run. Reducing couplings shall not be used. All conduits installed underground shall have a Class “C” Concrete, reference 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavments) envelope providing cover as indicated by the dimensions shown on the standard plates for standard duct sections.

3.10 ENCASED CONDUIT (SLOTTED OR TRENCHED)

Conduit to be encased in concrete shall be accurately placed and rigidly held in position so that line and grade are maintained when concrete is placed.

3.11 CONDUIT INSTALLATION UNDER EXISTING PAVED AREAS (BORED)

Conduit shall be placed under existing pavement by jacking, drilling, or directional boring methods. Pavement shall not be disturbed without permission from the Engineer, except at potholes, to expose utility lines in the street. Jacking or drilling pits shall be kept two feet (2′) clear of the edge of any type of pavement wherever possible. Excessive use of water, such that pavement might be undermined or softened, will not be permitted. In no case shall any water used in the Work, be allowed to enter any storm drain system. Jacking pits adjacent to railroad tracks shall be constructed not less than twelve feet (12′) from the centerline of track. When the jacking pit is left overnight, it shall be covered with substantial planking.

3.12 POLYVINYL CHLORIDE (PVC) CONDUIT AND FITTINGS

Conduit shall be cut with a saw and all ends shall be accurately tapered or otherwise finished depending on type of coupling specified. Tools recommended for this Work by the conduit manufacturer shall be used and finished ends shall be equal to those supplied by the manufacturer. All ends shall be smoothed of burrs and fins. Standard bends shall be used wherever possible and special bends shall preferably have a radius not less than, that of standard bends. All special conduits shall be accurately dimensioned and manufactured. All joints shall be sealed with waterproof joint sealing compound recommended by the conduit manufacturer and approved by the Engineer. All joints thus treated shall be waterproof. An expansion joint shall consist of a break in the conduit run with a space between ends of conduit as indicated on the Plans. A conduit sleeve not less than eighteen inches (18″) long, unless otherwise indicated, shall cover the break. The sleeve shall be rigidly anchored to the structure.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, backfill, conduit encasing concrete, hot mix asphalt, attachments, hangers, paint, bends, connections, fittings, mandrelling, pull ropes and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Conduit in trenches shall be paid for on a linear foot basis.

C. Conduit not monolithically incorporated into structure Construction shall be paid for at the Contract Unit Price per linear foot.

D. Conduit monolithically incorporated into structure Construction shall be paid for as a part of lump sum for the appropriate structure item.

26 56 12 TEMPORARY STREET LIGHTING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing temporary lighting in the event existing street lighting cannot be maintained during Construction. The Contractor shall be required to provide the temporary lighting and remove it after Construction is complete.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. Temporary lighting shall consist of a separate lighting system installed, maintained and removed by the Contractor. A separate power source will be required to be provided by the Contractor.

B. Temporary lighting shall correspond to existing lighting and provide a minimum initial lighting level of two (2) foot candles with a uniformity ratio not exceeding six to one (6:1).

C. The Contractor shall submit to the Engineer a layout proposal of temporary lighting and wiring proposed a minimum of four (4) weeks in advance of any interruptions of existing lighting. Temporary lighting shall not be installed until such layout is approved by the Engineer.

D. Temporary lighting shall be installed prior to the removal of the existing streetlights and shall not be removed until the permanent lighting is installed and operational.

PART 4 MEASUREMENT AND PAYMENT

The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 56 13 LIGHTING POLES AND STANDARDS (LIGHTING STRUCTURES)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing low level steel and aluminum lighting poles, bracket arms and fittings, as specified in the Contract Documents or as directed by the Engineer. Concrete foundations are excluded.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cast Iron. Iron castings shall conform to A 48, Class 30B.

B. Hardware. Spikes, wood screws, staples, brads, lag screws, carriage bolts and other parts under the general heading of Hardware shall be composed of carbon steel and shall conform to federal Specifications.

C. Conduit. Shall conform to 26 07 01.01, Part 2.

D. Lighting Structures shall conform to the following:

1. Lighting structures shall conform to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, based on ninety (90) mph wind loads, luminaire weight of seventy pounds (70 lbs) and luminaire projected area of three (3) ft^2.
2. Ground mounted lighting structures shall consist of a one (1) piece, round tapered shaft, a cast steel anchor base for steel structures and a cast aluminum base for aluminum structures, bracket arms, complete with all necessary accessories including anchor bolts, pole top, shims, grounding lug and handhold.
3. Steel shafts shall conform to A 595, Grade A. After forming and welding, the shaft shall have a smooth finish with only one (1) longitudinal weld and no transverse

welds. Steel bracket arms and mounting brackets shall conform to A 53, Schedule 40. Structures shall be either mechanically or hot dipped galvanized. The coating shall conform to the thickness, adherence and quality requirements of A 123.

4. Aluminum shafts and bracket arms shall be spun from one (1) piece of extruded tubing conforming to B 241, 6000 T6 series alloy. The shaft and bracket shall be cold worked to form the required taper.
5. Each lighting structure shall be provided with a permanent tag, which shall be two inches by four inches (2″ X 4″) fabricated from clear anodized one-sixteenth inch (1/16″) thick aluminum. The edge shall be smooth and corners rounded and the tag shall fit the lighting structure shaft. Tags shall be secured to shafts by means of four (4), one-eighth inch (1/18″) diameter, 18-8 stainless steel round head drive screws or self tapping screws. The identifying letters or numerals shall be a minimum of three-quarters inches (3/4″) high with a minimum stroke of three-sixteenths inch (3/16″). Identifying letters or numerals shall be as specified in the Contract Documents or as directed by the Engineer.

E. Galvanization shall conform to A 123.

F. Stainless Steel Hardware shall conform to A 167, Type 302.

G. Aluminum Castings shall conform to B 26 or B 108, alloy 356 T6.

H. Anchor Base Plate for Aluminum Structures shall conform to B 209, 6000 series alloy.

PART 3 EXECUTION

3.1 GENERAL

A. Refer to 10 14 15.02, (Concrete Foundations for Traffic Signals) for concrete foundations.

B. All fabrication and welding shall conform to 05 12 00, (Structural Metal Framing (metal structures)). After forming and welding, the pole shall have a smooth finish with only one (1) longitudinal and no transverse welds. When fully assembled, each lighting structure shall be installed so that the pole is vertical.

C. All welding for aluminum poles shall be metallic arc consumable electrode inert gas shielded process. After welding, the entire assembly shall be precipitation heat treated to the T 6 temper by an approved method and rotary sand finished.

D. All aluminum poles shall be furnished with internal vibration dampening devices.

E. Bracket Arms. The bracket arm shall be secured to the poles as specified in the manufacturer's recommendations. Each bracket arm shall be perpendicular to the roadway centerline unless otherwise specified. And be placed on anchor bolts projecting from the structure pedestal base and firmly bolted to the base. All nuts and shims shall be stainless steel.

F. All poles shall be wired to a HEB AA fuse kit. Install with a fifteen (15) amp KTK fuse. The required fuse kit shall be furnished and installed by others unless otherwise directed by the Engineer or specified in the Contract Documents.

G. All street light poles shall be installed complete, including poles, luminaries, arms, accessories, wiring and all associated equipment and incidentals required in to accomplish this item of Work.

3.2 LIGHT POLES – INNER HARBOR

A. Inner Harbor light poles shall be thirty-two feet (32′) long, square and uniformly tapered at a rate of .10″/ft. from nominal eight inch (8″) at base to nominal five inch (5″) at top of pole per Standard BC 808.17, sheet 1 and 2. The pole shall be a minimum of ten (10) gauge and fabricated from ASTM A606, type 4, high strength, low alloy, corrosion resistant hot rolled sheet. All poles shall be hot dipped galvanized to a minimum thickness of three-thousandths of an inch (.003″) in accordance with ASTM 123. Pole design shall be in accordance with the current edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. A design wind velocity of ninety miles per hour (90 mph) and ice and dead loads, as set forth in the ASSHTO publication, shall be used for pole thickness design. Calculations shall be submitted to the Engineer for review. Pole shall be capped with a removable, waterproof, vented steel cover fastened in place with stainless steel set screws. Poles shall be vented from base to top to prevent condensation in pole interior. Pole shaft shall be welded to a square steel base plate and furnished with a pole J hook wire support welded inside near the top of the pole.

B. Base plate shall accept tapered pole in a telescoping manner and be fastened thereto be two (2) continuous electric arc welds, as shown on Standard BC 808.17, sheet 1 of 2. Plate shall be drilled as details, to accept four (4), one and one-quarter inch (1-1/4″) diameter anchor bolts on a fifteen inch (15″) diameter bolt circle.

C. Base cover shall be a two (2) piece heavy gauge fabricated steel housing, approximately five inches (5″) high to protect pole anchor bolts and nuts. Cover shall be as detailed with angles and strips as shown to accept stainless steel hardware and to minimize cover removal and theft. Cover shall also provide for positive drainage of the base area and allow for venting of the pole.

D. Hand hole assembly shall be welded into the pole shaft above base and opposite side of luminaire housing. Opening shall be a nominal four inch by eight inch (4″ X 8″) with one-half inch (1/2″) radius corners with center of hand hole fourteen inches (14″) above finished grade. Handhole cover, when installed, shall be flush with the exterior face of the pole. The handhole opening shall be reinforced on the inside face of the pole as required to maintain the design strength of the pole and/or to furnish a means to attach the handhole cover.

E. A three-eighths inch (3/8″) grounding lug with nut shall be provided for all streetlights. The lug shall be located interior to the pole and on the pole side opposite the hand hole.

F. The pole, hand hole and cover shall be cleaned and primed and receive an electrostatically deposited polyester powder coating in Duranodic 312 Bronze. Additionally, pole shaft shall receive rust inhibiting coatings on their interiors for a minimum distance of eighteen inches (18″) from both pole top and bottom. Poles shall be drilled and deburred at the top, prior to finishing operations, to accept luminaire bracket arm. Hole to provide access to bracket are for wiring purposes shall receive a rubber grommet to ensure against abrasion of conductor insulation.

G. All fasteners, bolts, washers and nuts shall be stainless steel. Internal steel reinforcing plates shall be two (2) RC cold galvanized after fabrication. All joints shall be tight and.

have a long term fatigue resistance in conformance with AISC Specifications to withstand wind loads per structural requirements.

3.3 ALUMINUM STANDARDS – COBRA HEAD

A. Light pole shall be twenty-seven feet, six inches (27′-6″) long, round tapered aluminum pole per Standard BC 808.02 or twenty-two feet, six inches (22′-6″) long round tapered aluminum per Specification BC 808.01.

B. Shaft may be either cold rolled or spun aluminum at the option of the Contractor and shall conform to the following:

1. Spun aluminum shafts shall be formed from (1) piece of seamless tubing and be of Aluminum Association Alloy 6063 or equal, and after fabrication, it shall have no longitudinal or circumferential welds, except at the lower end joining the shaft to the base. Shafts for twenty-five foot (25′) and thirty foot (30′) Standards shall have a wall thickness of one-thousand eight-hundred eighty-eight ten-thousandths inch (0.1888”), all shafts shall contain a four inch by eight inch (4″ X 8″) flush type handhole with cover held in place with stainless steel tamperproof screws. After welding, the shaft shall be artificially aged by heat treating to a T6 temper. All other shaft dimensions shall be as specified herein and/or as shown in the Contract Documents. A suitable adaptor or grommet shall be provided in the opening in the shaft for cable entrance from the shaft into the bracket arm which will provide a smooth cable guide for wiring. The top of the shaft shall be equipped with a removable cast aluminum ornamental cap secured in place with stainless steel set screws. Pole cap and anchor bolt covers shall be cast of Aluminum Association Alloy 43.
2. Cold rolled aluminum shafts shall be fabricated from (1) piece of sheet or plate of Aluminum Association Alloy 5052 or equal and shall have diameters and wall thickness as specified for spun aluminum shafts above. Each shaft shall have one (1) longitudinal weld performed by the metallic arc consumable electrode inert gas shielded process. After welding, the shaft shall be longitudinally cold rolled to the desires shape to develop the mechanical prosperities listed for H 34 temper. The shaft shall have no circumferential welds, except at the lower end joining the shaft to the base. In all other respects, the cold rolled aluminum shafts shall be the same as specified for the spun aluminum shafts above.

C. Anchor bases: A one (1) piece cast anchor of Aluminum Association Alloy 365 T6 of adequate strength, shape and size shall be secured to the bottom of the shaft by two (2) continuous welds. The base shall telescope the shaft and one (1) weld shall be on the inside at the base of the end of the shaft, while the other weld shall be on the outside at the top of the base. The two (2) welds shall not be less than three inches (3″) apart so the weld connection shall develop the design strength of the pole assembly. The base shall be provided with four (4) slotted holes to receiving the one inch (1″) diameter anchor bolts places on an eleven inch (11″) bolt circle and eight (8) tapered holes for securing four (4) ornamental cast aluminum bolt covers to the base. The four (4) slots shall permit a clear slot opening of nine and three quarters inches (9 3/4″), allowing a minimum of one-quarter inch (1/4″) clear in the anchor bolt at eleven inch (11″) bolt circle. The other slot openings shall be thirteen and one quarter inch (13-1/4″) clear. A three-eighths inch by one and one-half inch (3/8″ X 1-1/2″) grounding stud and two (2) nuts of stainless steel shall be provided inside of the shaft as indicated on the plans. A neoprene gasket shall be furnished and installed with all poles.

D. Single member bracket arm assembly shall be furnished where a six foot (6′) or eight foot (8′) bracket arm is specified and shall be ovaliptic consisting of tapered tubing made of Aluminum Association Alloy 6063 T6 having an elliptical section at the pole which tapers from four and one-half inches (4-1/2″) OD to two and three-eighths inches (2-3/8″) OD at the luminaire end, respectively. The pole end of the arm shall have a cast aluminum fitted bracket welded to it, which will permit the positioning of the arm on the plate of the pole, held only by gravity. The arm is secured to the pole be stainless steel cap screws, providing a weather resistant connection and a smooth wiring raceway. If single mast arm is used, a cover plate with bolts for each pole bottom bracket attachment must be provided and installed.

E. Truss type member bracket assembly shall be furnished where a ten foot (10′), twelve foot (12′) or fifteen foot (15′) bracket arm is specified and shall consist of an upper and lower member securely joined be means of vertical struts. The upper arm assembly shall be the same as the single arm assembly. The lower member shall be two inches (2″) IPS aluminum pipe. The pole end of each member shall have a cast aluminum fitting welded to it, which will permit the positioning of the bracket arm assembly on the plate of the pole, held only by gravity, while the arm is secured to the pole by cap screws, providing weather resistant connection and smooth wiring raceway. Aluminum tubing shall be IPS pipe used in fabrication of the bracket arm assembly shall be Aluminum Association Alloy 6063 T6, respectively. Castings shall be alloy 356 T6.

F. FINISHES

1. All hardware (nuts, bolts and washers) except for anchor bolts shall be stainless steel.
2. Pole shafts and bracket arms shall have a satin brush finish producing a nonreflective outer surface. Anchor base, pole caps and nut covers shall have a wet blast silver grey satin finish.
3. Pole shafts and bracket arm assemblies shall be tire wrapped with a water resistant paper or approved method for protection of finish during shipment and installation.

G. All welding shall conform to the approved and accepted method of welding aluminum alloy. Welding shall be done only by welders certified by the Independent Training Laboratory to the requirements of the latest edition of ASTM Boiler and Pressure Vessel Code, Section IX and their credentials shall be made available to the Engineer upon request.

H. Aluminum light standards and brackets shall conform to NEMA Test Requirements for Metals. Each aluminum light standard shall be able to withstand a five hundred (500) pound transverse load applied eighteen inches (18″) from the top of the shaft without fracture and a maximum deflection of not more than seven and five-tenths percent (7.5%) of shaft length. After removal of the load, the shaft shall take a permanent set of not more than one-half inch (1/2″). Each anchor base shall be capable of withstanding the maximum allowable bending movement of the shaft. Each bracket arm, when attached to the shaft, shall withstand a vertical load of one hundred (100) pounds and a transverse load of fifty (50) pounds, applied at the luminaire end of the bracket arm without fracture or deformation after the load is removed.

3.4 PMA POLES

A. PMA light poles shall be eleven feet, six inches (11′-6″) long per Standard BC 808.06. Shafts may be either spun aluminum or cold rolled aluminum at the option of the Contractor.

1. Spun aluminum shafts shall conform to the same Specifications as Cobra Head poles above in 26 56 13, 3.3, B, 1 and dimensions shown on Standard BC 808 06.
2. Cold rolled aluminum shafts shall conform to the same Specifications as Cobra Head shafts above in 26 56 13, 3.3, B, 2.

B Anchor base for PMA poles is the same as Cobra Head poles above in 26 56 13, 3.3, C.

3.5 OTTERBEIN POLES

A. Decorative pedestrian aluminum light poles as per Baltimore Standard BC 808.16.

1. Anchor base type: Pole to compliment the period lantern now being used in the historic areas of the City. Designed in accordance with accepted engineering practices to be structurally adequate for one hundred (100 mph) mile per hour design wind load with minimum 1.5X safety factors.
2. Pole dimensions and appearance are vital to the compatibility not only on new installations, but also for replacement parts.
3. Finish to be flat black powder coat, coated with a polyester powered resin which is then baked at a high temperature, finish laboratory tested for weather ability and fade resistance in accordance with ASTMB117 64 and ANSI/ASTMG53 77 Test Specifications.
4. Post top tenon to be three inches (3″) O.D. with cast aluminum ladder, rest twenty and one-quarter inches (20-1/4″) long with painted gold leafing on flat black powder coat finish and tamperproof screws.
5. Structure is of one (1) piece welded Construction. Post of extruded aluminum four inches (4″) O.D. by .0188 wall by nine foot (9′) long. Post slips into fluted base six inches (6″) as noted in detail from Special Provisions titled “Decorative Pole and Tenon”.

B. Otterbein top section of base to be cast aluminum round with sixteen (16) flutes plus removable cast aluminum door with two (2) stainless steel tamperproof screws. Bottom of base to be cast aluminum octagonal in shape with removable cast aluminum door with two (2) each tamperproof stainless steel screws and ground lug inside base. Door to have cast brass wreath. Base with cast slots for customer use, which is concealed by base cover. For anchor rods, nuts and base, refer to the detail titled “Bolton Hill, Fells Point and Otterbein Base” in the Contract Documents.

1. Anchor bolt cover is eleven and one-half inches (11-1/2″) square cast aluminum with two (2) each stainless steel tamperproof screws and two (2) notches at customer request.
2. Overall height of pole to be approximately twelve feet (12′) as required.
3 Pole and luminaire, when assembled, shall have a total height above ground of approximately sixteen feet (16′).

3.6 HOMELAND POLE

A. Lighting post shall be aluminum, gracefully made with a deep ten (10) flute pattern and classic double fluted base.

B. Base material shall be all aluminum Construction formed true to the pattern with complete detail. All hardware shall be tamper resistant stainless steel.

C. Post shall be ten feet, six inches (10′-6″) high with a sixteen inch (16″) diameter base. Post shall be a minimum four inch (4″) O.D. an integral three inch (3″) tenon shall be provided at the top for fixture mounting. Pole wall shall be one-hundred eighty-eight thousandths inch (.0188″) thick.

D. Pole shall be suitable for mounting on existing forty-eight inch (48″) steel sub base with eleven inch (11″) bolt circle and notched to accept four (4) one inch (1″) diameter anchor bolts. An access door shall be provided.

E. Finish is same as Otterbein finish in 26 56 13, 3.5, A, 3.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Lighting Structures will be measured and paid for at the Contract Unit Price per each pole height, bracket arm length and material type actually installed and accepted by the Engineer.

C. Concrete Foundation will be measured and paid for as specified in 10 14 15.02, (Concrete Foundations for Traffic Signals).

D. Breakaway Base Support Systems, when specified in the Contract Documents, will be measured and paid for as specified in 10 14 15.08, (Breakaway Base Support System).

E. Bracket arms for signal structures or wood poles will be measured and paid for at the Contract Unit Price per each for the pertinent Bracket Arm item.

26 56 13.01 REMOVE AND RELOCATE OR REMOVE AND DISPOSE OF ROADWAY LIGHTING STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of removing and relocating or removing and disposal of roadway lighting structures as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hardware shall conform to 26 56 13, Part 2, (Lighting Structures).

B. Conduit shall conform to 26 07 01.01, Part 2, (Electrical Conduit and Fittings).

PART 3 EXECUTION

A. Concrete foundations shall be removed as specified in 02 41 13.14, Part 3, (Minor Selective Site Demolition). All holes caused by this removal shall be backfilled and compacted as approved by the Engineer. Lighting structures removed and not reused shall remain the property of the City, unless otherwise directed by the Engineer or specified in the Contract Documents. Lighting structures scheduled to be reused on the same project, shall be removed and stored by the Contractor to assure the preservation of their quality and acceptability for the Work. Stored materials may again be inspected prior to their use in the Work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the right-of-way or project site may be used for storage purposes. Storage areas must be restored to their original condition by the Contractor at its expense. Any additional space required must be provided by the Contractor at its expense.

B. All existing cable shall be made safe and in conformance with the appropriate electrical codes, as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Removal and Disposal of Roadway Lighting will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for the removal and disposal of the lighting structure, removal of existing concrete foundation and all material, labor, equipment, tools, and incidentals to complete the Work.

B. Removal and Relocation of Roadway Lighting Structures will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for the removal, storage, reinstallation, connection to existing lighting circuits, removal of existing concrete foundations, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 56 13.02 CUTTING AND CAPPING MAST ARMS AND POLES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of cutting, cleaning, galvanizing and capping mast arms, mast arm poles, pedestal poles, and strain poles as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

Cold Galvanizing Compound shall conform to A 780.

PART 3 EXECUTION

A. Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in A 780.

B. Saw cut the pole or mast arm to the required length. Clean the affected area inside and outside with a wire brush. Spray cold galvanizing compound on the affected area. Place an end cap of matching size.

PART 4 MEASUREMENT AND PAYMENT

Cutting and Capping of Mast Arms and Poles will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for cutting, cleaning, galvanizing, capping and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

26 56 14 LIGHTING AND SIGNAL POLE BASES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing concrete foundations for installing traffic signals, highway lighting, joint use pole bases, and signs including the furnishing and installing of a specified base with conduit connection and plugs, anchor bolts with steel nuts and washers, protective sleeves and nuts and greasing of bolts as shown at locations specified in the Contract Documents or as described in the Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Class Mix No. 3 – Refer to 03 30 00, (Portland Cement Concrete Structures).

B. Steel Reinforcement – Refer to 03 21 00, (Reinforcing Steel).

C. Conduit – Refer to 26 07 01.01, (Electrical Conduit and Fittings).

D. Anchor Bolts, Nuts and Washers – Refer to Contract Documents.

E. The bore of conduit shall be straight, and the circular cross section shall not vary more than one-eighth inch (1/8″), from the nominal diameter. The inner surface shall be free from excess compound, rough and flaky areas, dents and obstructions when gauged by the passage of a mandrel sized one and one-quarter inch (1-1/4″) less in diameter than the nominal inside diameter of the conduit.

F. The conduit shall have joints of the drive type, each length being provided with a tapered sleeve coupling.

G. Where galvanizing is called for, the parts shall be hot dipped in accordance with ASTM Specification A123.

H. Anchor bolts and templates for bases for traffic signal poles shall be furnished by the Engineer.

PART 3 EXECUTION

3.1 GENERAL

A. Exercise extreme caution during all Construction operations adjacent to existing utilities and structures slated to remain in service.

B. Curbs: New curbs shall be installed prior to the installation of any pole bases.

C. Excavation: The Contractor shall perform all excavation to the dimensions specified in the Contract Documents. All excavation Work will be inspected and approved by the Engineer before proceeding with Construction. The Contractor shall excavate with extreme care and construct the roadway pedestal bases at locations shown on the Contract Plans and/or as directed by the Engineer.

D. Unusual Soil Conditions: When unexpected subsurface conditions are encountered, the excavation depth shall be modified as directed by the Engineer. Rock or boulders, which cannot be removed by ordinary means, shall be removed to the levels and dimensions specified in the Contract Documents or to a depth necessary to obtain the required stability as directed by the Engineer. Where local obstruction or underground structures prevent the installation of any base as specified, the Contractor shall request approval from the Engineer for a new location.

1. The Contractor shall excavate for the complete base as detailed and as shown in the Contract Documents regardless of material encountered, whether it is rock, stone rubble, as determined by the Engineer, the unsuitable material shall be removed and replaced with suitable material and compacted with a mechanical or vibrating tamper of an approved type to the satisfaction of the Engineer. In fill areas, the fill shall be completed prior to the Construction of the bases. The excavation may be augered with an approved size auger, provided that the top six inches (6″) of the base is blocked square.
2. Approved material selected from the excavation shall be used for backfill. Excavation and backfill shall be performed in accordance with Standard Specifications.
3. When General Conditions prevent the installation of any base as specified, the Contractor shall request approval from the Engineer for a new location.

E. Fittings: Galvanized parts that have been cut or chipped to bare metal shall be repaired as specified in ASTM specification A123.

1. PVC conduit of the type, number and size specified shall be placed in each base. Unless otherwise directed, this conduit shall be placed in the base with the underground entry end facing toward the proposed power feed. If no conduit is specified, a single three inch (3″) conduit shall be installed facing away from the curb. Do not encase the exit ends of conduit in concrete.
2. All conduits shall be plugged at both ends by means of a standard tapered plug. The void in these plugs shall be filled with cement grout and finished flush with the surface of the plug.
3. In addition to the above, galvanized pipe sleeves and galvanized steel hexagon nuts having unified course threads, shall be installed on the threaded portion of all bolts projecting above the top surface of the bases to provide protection of the bolts until installation of the poles. Each sleeve and nut shall be well lubricated

with a nonoxide grease before use. If so required by the Engineer, the bases shall be entirely covered by soil to protect them from damage and vandalism.

4. The Contractor's attention is directed to the stainless steel nuts and washers for bases as specified above. Although these nuts and washers are to be furnished, they are not to be installed in the Work, but are to be delivered to the Engineer for future installation by others.
5. After installation of the pole the Contractor shall provide and install a temporary cover to protect the anchor bolts and prevent them from becoming a tripping hazard. The temporary cover is to be a minimum of thirty inches (30″) high, bolted on at least two (2) opposite anchor bolts and shall be bright orange in color.

F. Concrete Placement: It is intended that all concrete be placed against undisturbed earth. However, where the existing ground will not retain its shape during or after excavation or if the excavation should show any tendency to cave in before placing the foundation, the Contractor shall provide and install a corrugated metal sleeve or form of required size to retain the earth and receive the concrete. The form shall remain in place.

G. Concrete shall be mixed, handled, placed, cured and tested as specified in 03 30 00, and these special provisions. Footings including reinforcement and bolt circle data shall be as specified in the Contract Documents and in conformance with the approved working Drawings. Anchor bolts shall be plumb. Suitable templates for setting anchor bolts shall be accurately placed and left in place until the concrete has attained its initial set.

1. Exercise care during concrete pour to avoid movement or displacement of reinforcement cage, template set anchor bolts and entering duct.
2. Precast concrete caps are not permitted.
3. The entire base, excluding the nonshrink grout, shall be placed as a unit to form a one (1) piece monolithic concrete structure.
4. The top of the base shall be finished smooth, level and true to the grade shown in the Contract Documents, meeting the lowest adjacent grade, or as directed by the Engineer.
5. Concrete shall be terminated at elevation shown on the Contract Documents to enable leveling nut adjustment.
6. All pedestal bases shall have their upper exposed edges chamfered one-half inch by one-half inch (1/2″ X 1/2″) to prevent chipping.
7. Tops of foundations shall be troweled to a dense smooth finish. Exposed surfaces shall be cured by use of a liquid membrane curing compound.

H. Anchor Bolts: Anchor bolts shall be firmly held in place in the forms and accurately located to the dimensions shown by the use of approved templates.

1. Two (2) adjacent anchor bolts shall be on a line parallel to the roadway, on all pedestal bases, unless otherwise indicated on the Contract Plans.
2. Anchor bolts shall project above the surface of the finished surface of the concrete as shown on the Contract Documents, with hooked ends set with hooks toward center of the pedestal.
3. Bolt circles for the various bases shall be as detailed in the Contract Documents or as specified by the Engineer.

I. Backfill: Material used for backfill shall be free of topsoil, organic, frozen, or other undesirable material. Spaces to be backfilled shall be kept free of trash and shall be cleaned before backfill is placed. Backfill material shall be suitable material from the

excavation or other sources conforming to 31 23 23.13, (Selected Backfill). All backfill shall be compacted in layers not exceeding 8 inches loose thickness. Compaction shall be done with mechanical or vibratory compaction equipment to obtain at least ninety-two percent (92%) of maximum density at moisture content within two percent (2%) of the optimum in conformance with T 180, Method C.

3.2 ROADWAY PEDESTAL BASE, STEEL SUB BASE

A. The Contractor shall furnish and install steel sub bases where required for proposed street light poles. The steel sub base shall be in conformance with the appropriate Baltimore City Standard for steel sub bases.

B. The depth of excavation for the base shall allow for crushed aggregate (CR 6) or recycled concrete (RC 6) to be placed and compacted to a depth of four inches (4″) in the bottom of the excavation crushed aggregate or recycled concrete specified herein shall conform to requirements specified elsewhere in the Specifications.

C. The steel sub base shall be installed and the area around the base shall be filled and compacted with approved material selected from the excavation. Crushed aggregate (CR 6) or recycled concrete (CR 6), compacted in place, shall be used to replace unsatisfactory material from the excavation.

D. The top of the base shall coincide with the lowest final adjacent grade. On slopes, the base shall be flush with the lowest part of the grade. The brace plate shall be installed nearest to the curb and parallel with it.

E. A one to three inch (1″ to 3″) PVC conduit elbow shall be installed in each base directed toward the proposed power feed. The bolt circle and size shall be detailed in the Contract Documents. All hardware shall be stainless steel.

PART 4 MEASUREMENT AND PAYMENT

A. This Work will be paid for at the Contract Unit Price bid per each for the specific lighting or signal pole and/or joint use pole base indicated in the proposal after acceptance of the Work by the Engineer. This price and payment shall constitute full compensation for all materials, labor, tools, equipment, hauling, cement concrete, formwork, anchor bolts, stainless steel nuts and washers, protective sleeves and nuts, galvanizing, delivery of stainless steel nuts and washers, and all excavation, furnishing and placing crushed aggregate or recycled concrete, backfilling, compaction, re-compaction, disposal of unsuitable material and incidentals necessary to complete the Work.

B. The cost of supporting, bracing, protecting and maintaining existing utility systems in service is the full responsibility of the Contractor and for which additional compensation will not be allowed.

DIVISION 28
ELECTRONIC SAFETY AND SECURITY
28 13 00 ACCESS CONTROL

28 13 00 ACCESS CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

The Contractor shall provide a photograph identification badge for each member of its workforce.

PART 2 PRODUCTS

2.1 MATERIALS

Identification badges.

PART 3 EXECUTION

3.1 GENERAL

Each individual shall display the identification badge before entering the project site and as requested during their presence on the project site. The identification badge shall include the individual's photograph, name, organization, and the contract number. Contractor's workforce shall include, but is not limited to, subcontractors, suppliers, manufacturers' representatives, testing agencies, etc. The Contractor shall furnish a photocopy of an individual's identification badge to the Engineer prior to the individual's beginning work at the site. In those instances where the duration of an individual's on-site visit is to be very limited, the Contractor will issue a temporary, non-photo, identification card. The individual may not enter the site until the temporary, non-photo, identification card is issued.

PART 4 MEASUREMENT AND PAYMENT

The Contractor shall provide all the necessary labor, materials, tools, equipment and devices for the creation of the identification badges at no additional cost to the City. No separate payment will be made for acquiring the badges. The cost thereof shall be considered as included in the lump sum price bid for the Contract.

DIVISION 31
EARTHWORK

31 09 00 GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK

31 09 16.23 DRIVEN PILE LOAD TESTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of applying loads to test piles when the Contract Documents include load tests. The load test setup, the measuring system, the loading device, the loading procedure, the frequency of measuring the movement of piles and the record keeping shall conform to D 1143 unless otherwise specified in the Contract Documents or directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. At each load test location, the Engineer will provide driving criteria for the test pile. The pile shall then be driven and load tested to the test load specified in the Contract Documents or as directed by the Engineer. If the pile fails to achieve this capacity, an additional load test shall be performed on a second test pile. This pile shall be located adjacent to the initial test pile and driven according to revised driving criteria provided by the Engineer. The Engineer may elect to have the Contractor re-drive piles that do not conform to the required penetration resistance.

B. The equipment and methodology used for driving the load test piles shall be the same as the equipment and methodology used for driving the permanent piles.

C. At each load test location, the Contractor shall construct a test enclosure to protect all of the equipment including dial gauges, load cells, loading apparatus and the personnel taking readings. Heat shall be provided, if necessary, so that a minimum temperature of fifty degrees (50°) F is maintained within the enclosure. The test enclosure shall be adequately illuminated so that the readings can be taken inside the enclosure at all times of the day. The enclosure shall be ventilated to prevent fogging or frosting of gauges.

D. The Contractor shall submit Drawings to the Engineer showing all details of the proposed load test setup. The submittal shall include the method of applying the load, the reaction frame and reaction pile configuration, if used, and the placement and support of measuring devices. The submittal shall be made at least seven (7) days prior to the start of the first pile load test. The Contractor shall revise the load test setup if directed by the Engineer.

E. The reaction frame shall be designed by a professional Engineer experienced in structural design and registered in the State of Maryland.

F. The load test setup shall be capable of supporting the test load for the duration of the test.

G. The clear distance from reaction piles to the test pile shall be at least ten (10) times the distance from the midpoint of web to end of flange for H piles or ten (10) times the radius of pile at the top for pipe piles or timber piles.

H. Where necessary, and if directed by the Engineer, the unsupported length of load test piles shall be braced to prevent buckling, without influencing the test results.

I. The primary instrument for measuring the movement shall be a dial gauge. The dial gauges shall have an accuracy of one-thousandth inch (0.001″) and shall have a minimum travel of two inches (2″). Three (3) dial gauges spaced one hundred twenty degrees (120°) apart shall be used for measuring the movement of the top of the pile. A secondary system consisting of a scale, mirror and piano wire shall be used to measure the movement of the pile top.

J. Load apparatus shall conform to D 1143, "Apparatus for Applying Loads". The loading apparatus shall have a capacity of one hundred fifty percent (150%) of the test load. The maximum operating load of all jacks shall be eighty-five percent (85%) of its total capacity. If more than one (1) hydraulic jack is used, the jacks shall be of the same piston diameter, connected to a common manifold and pressure gauge and operated by a single hydraulic pump.

K. Loads shall be applied uniformly without impact. If hydraulic jacks are used, they shall be equipped with automatic regulators so that constant pressure can be maintained for the long-term test without frequent manual adjustment.

L. Unless weights of known magnitude are used to load the test piles, the primary method of measuring the test load shall be by a load cell with an accuracy tolerance within plus or minus two percent (±2%) of the applied load. The load cell shall be calibrated prior to the test and a copy of the calibration report supplied to the Engineer. A pressure gauge shall be provided as a secondary system. The pressure gauge, hydraulic ram, and hydraulic pump shall be calibrated as a unit to accuracy within five percent (5%) of the applied load. The use of a single high capacity jack is preferred to the use of multiple jacks. When a multiple jacking system is used, each jack shall be fitted with a pressure gauge in addition to the master gauge in order to detect malfunctions.

M. Load measuring devices shall be recalibrated if required by observed performance.

N. The load test pile shall be cut off in a manner that ensures a surface that is perpendicular to the longitudinal axis to allow for full bearing of the test pile. A steel plate of one inch (1″) minimum thickness shall be placed over the cutoff surface in a manner that facilitates axial loading and even bearing on the test pile.

O. The test procedure for all test piles driven to the embedded depths specified in the Contract Documents shall be the standard loading procedure conforming to D 1143 or as directed by the Engineer. Loading shall be continued to the specified test load or to failure, whichever occurs first.

P. The Contractor shall provide equipment to determine if reaction piles are moving. A scale attached to the reaction piles that can be monitored with a transit shall be used for this purpose.

Q. If at any stage during the test, the Engineer detects malfunctioning of any apparatus furnished by the Contractor or the load is being eccentrically applied or the anchor piles are yielding, the Engineer will order the test abandoned and the Contractor shall replace it with another test at no additional cost to the City. The Contractor shall have all necessary personnel present at the site at all times during the performance of the test to maintain the required load.

R. After the pile test program is complete, anchor (reaction) piles shall be removed or cut off as specified in the following:

1. The tops of all piles and pile casings, except timber piles that support timber caps, shall be cut off at the elevations specified in the Contract Documents and on a true plane perpendicular to the axis of the pile unless otherwise specified. Timber piles that support timber caps shall be cut off to ensure that the plane of the bottom of the cap will bear fully on the pile head. Shimming between the timber cap and pile head is prohibited.
2. Piles used for sheeting and shoring shall be cut off a minimum of one foot (1') below existing grade, channel bottom or mud line as applicable. When specified in the Contract Documents, these piles may be removed. The Contractor shall dispose of all removed material on approved spoil areas.

S. Steel pipe piles shall be load tested before filling.

PART 4 MEASUREMENT AND PAYMENT

When the project includes an item for load test, it will be measured and paid for at the Contract Unit Price per each for the pertinent load test items. The payment will be full compensation for furnishing and installing all equipment, Drawings, monitoring, recording, removal of all devices at the completion of the tests and for all material, labor, equipment, tools and incidentals necessary to complete the Work. In the event that the properly conducted load test fails to achieve the designated capacity, the additional tests will be measured and paid for at the Contract Unit Price per each under the load test item

31 11 00 CLEARING AND GRUBBING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of clearing and grubbing within the limits specified in the Contract Documents.

1.2 DEFINITIONS

A. Clearing: Clearing within the Construction Area Limit of Disturbance (LOD) includes removing and disposing of trees, brush, shrubs, vegetation, rotten wood, rubbish, fences and structures not specified in the Contract Documents for removal and disposal. Clearing

outside the Construction area (LOD) is the removing and disposing of rubbish only. No heavy equipment may be operated outside the LOD, unless permission is received by the project Engineer.

B. Grubbing: Grubbing is removing from the ground and disposing of all stumps, roots and stubs, brush and debris.

C. Cut: Cut means removal of a woody plant, wherein the stump and root mass remain in place intact.

D. Limits: Limits of clearing and grubbing include the Limits of Disturbance as shown on approved Construction Plans.

E. Clearing and Grubbing Unit: A clearing and grubbing unit is the area of erodible earth material exposed at one (1) time, not to exceed twenty (20) acres.

F. Disturbed Area: Any erodible material exposed by Construction activities.

G. Stabilization: Providing vegetation or structural measures (seed, temporary or permanent mulch, soil stabilization matting, riprap, stone aggregate, and paving by asphalt or concrete) that will prevent erosion. The placement of one (1) or more of these temporary or permanent stabilization measures as directed by the Engineer shall satisfy the requirements to proceed with the next grading unit or operation.

H. Stabilized: An area covered with erosion resistant material such as grass cover, seed and mulch, soil stabilization matting, riprap, stone aggregate, or paving by asphalt or concrete.

PART 2 PRODUCTS

2.1 MATERIALS

Not Applicable.

PART 3 EXECUTION

3.1 EROSION AND SEDIMENT CONTROL

A. Unless otherwise specified in the Contract Documents or as directed by the Engineer, the clearing and grubbing area shall be limited to a twenty (20) acre grading unit per grading operation. Once this first unit is half graded, the Contractor will be allowed to proceed with the second twenty (20) acre grading unit. With the permission of the Engineer, the Contractor will be allowed to exceed the one (1) grading unit requirement to balance earthwork or when grading interchanges. Erosion and sediment control shall conform to the Contract Documents and 31 25 00.01, (Erosion and Sediment Control).

B. A grading operation is defined as the Contractor's ability to provide adequate resources to perform the grading in a timely manner and provide and maintain the proper erosion and sediment control measures and tree protection devices (where applicable). The Engineer will be the final authority in this determination for sediment and erosion control. The Tree Protection Expert shall be the final authority for decisions relative to tree protection Work. A grading unit need not be twenty (20) contiguous acres. When wet soil conditions are encountered, the Contractor will be allowed to clear and grub and grade another unit

providing the initial unit has been properly stabilized. No more than two (2) grading units shall be active at any time.

3.2 VEGETATION

The Tree Protection Expert will designate and mark any trees, shrubbery and plants that are to remain in place, and the Contractor shall protect them from any damage as specified in 31 13 13.01. Branches of trees overhanging the roadway shall be cut and properly trimmed to maintain a vertical clearance of sixteen feet (16′). All trimming shall be done under the supervision of a tree expert employed by the Contractor and licensed by the State of Maryland, including trimming of trees by the Contractor for any other reason. Trimming and repair of cuts and scars shall conform to 31 13 16, (Selective Tree Trimming).

3.3 FENCES

All fences within the right-of-way and/or Limit of Disturbance shall be removed and disposed of unless otherwise specified in the Contract Documents.

3.4 MAILBOXES

All mailboxes within the limits of Construction or Limit of Disturbance shall be removed and reset as directed by the Engineer.

3.5 GRUBBING

A. Excavation Areas: Within areas to be excavated, all embedded stumps and roots shall be removed to a depth of not less than three feet (3′) below the subgrade or slope surfaces. All depressions made below the subgrade or slope surfaces by the removal of stumps shall be refilled with materials suitable for embankment and shall be compacted as specified in 31 24 13.10, (Embankment and Subgrade).

B. Low Embankments: Areas where the total depth of the embankment is less than three feet (3′) shall be grubbed.

C. High Embankments: Areas where the embankment is three feet (3′) or more in depth, trees and stumps shall be cut off as close to the ground as is practical but shall not exceed one foot (1′) above the ground surface. Near the toe of embankment slopes, stumps or trees are prohibited within one foot (1′) of the slope surfaces.

3.6 STREAM AND CHANNEL CHANGES

Stream or channel change areas shall be cleared and grubbed five feet (5′) beyond the top of the cut slopes unless specified otherwise in an approved tree protection plan as per Article 7, Forest and Tree Conservation, City Code.

3.7 DISPOSAL

A. Burning: When perishable material is burned, it shall be burned under the constant care of a watchperson. Burning shall conform to the applicable laws and ordinances of respective jurisdictions.

B. Disposal Locations: Materials and debris that cannot be burned and perishable materials shall be removed from the right-of-way and disposed of by the Contractor. The Contractor shall make all necessary arrangements to obtain suitable disposal locations and shall furnish the Engineer with a copy of resulting agreements.

C. Wood Disposal: Disposal of wood to the general public shall be accomplished off the job site. Any plan for disposal in this manner shall be submitted to and approved by the Engineer prior to beginning the clearing and grubbing operation.

3.8 DESTROYING TREES OR WETLANDS, BEYOND CLEARING LIMITS

A. The Contractor shall not damage nor destroy any trees or wetland areas that exist beyond the clearing limits specified or the approved Limit of Disturbance.

B. The Contractor shall be responsible for all damage to trees and wetlands located beyond the clearing limits or LOD due to the Contractor's operations. The Contractor shall restore, to the satisfaction of the Tree Protection Expert, any trees that have been damaged or destroyed at no additional cost to the City. Replacement of trees shall be in conformance with 32 90 00.01, (Planting Trees Shrubs and Vines). In addition, the Contractor shall be responsible for all fines associated with Article 7, Division IV, Forest and Tree Conservation as determined by the Tree Protection Expert.

C. Mitigation of wetland impact shall be in conformance with the Occupying Wetlands provisions contained in the Contract Documents.

D. Replacement trees shall be of the same species as those damaged or destroyed unless otherwise directed by the Tree Protection Expert. The replacement size shall be the same as the damaged or destroyed trees when the trees measure less than four inch (4″) diameter at breast height (DBH). Damaged trees four inch (4″) DBH or greater shall be replaced with two inch (2″) caliper trees in conformance with the following:

SIZE OF DAMAGED OR DESTROYED TREES inch DBH	NUMBER OF 2-inch CALIPER REPLACEMENT TREES
4	5
6	8
8	10
10	13
12	15
16	20
20	25
24	36
32	48
40	80
60	135
80	200
120 or Greater	360

Note: DBH shall be measured at four and one-half feet (4.5′) above the ground. Caliper shall be measured at six inches (6″) above the ground.

E. Replacement trees shall be planted within the limits of the project whenever possible, as determined by the Tree Protection Expert. If not possible, a suitable location will be determined by the Tree Protection Expert.

F. All Work shall require a replacement period as specified in 32 90 00.01. In case of failure on the part of the Contractor to restore or replace the damaged tree or wetland at the start of the next appropriate planting season, the Contractor will have forty-eight (48) hours to begin corrective action, after notification by the Engineer and the Tree Protection Expert. If the Contractor has not taken the corrective actions within the specified time, the Engineer may proceed with corrective measures. The cost of the corrective measures will be deducted from any monies due under the Contract.

PART 4 MEASUREMENT AND PAYMENT

Clearing and Grubbing will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for the removal and disposal of fences, removal and resetting of mailboxes, selective tree trimming and scar repair, and removal and disposal of existing buildings when not covered as a specific pay item in the Contract Documents, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

31 12 00 SELECTIVE CLEARING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of trimming, sloping and shaping existing ditches, within the Limits of Disturbance and to the lines and grade as specified in the Contract Documents. Clearing and grubbing and the removal and disposal of surplus or unsuitable materials are included in the Work.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

Clearing and grubbing for trimming existing ditches shall conform to 31 11 00, (Clearing and Grubbing). Existing ditches shall be trimmed, sloped, and shaped to a uniform grade and cross section. The side slopes shall be constant with a maximum slope of one to one (1:1) unless otherwise specified. Excess or unsuitable materials removed shall be disposed of as specified in 31 23 16.10, (Roadway Excavation Class 1, Class 1-A, Class 2).

PART 4 MEASUREMENT AND PAYMENT

A. Trimming Existing Ditches will be measured and paid for at the Contract Unit Price per linear foot of existing ditches on which Work has been completed. Measurement will be along the centerline of the ditch.

B. The payment will be full compensation for all clearing, grubbing, excavation, and disposal of surplus and unsuitable materials and for all labor, equipment, tools, and incidentals necessary to complete the Work.

31 13 00 SELECTIVE TREE AND SHRUB REMOVAL AND TRIMMING

31 13 13.01 TREE PRESERVATION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the establishment of a Tree Preservation Area (TPA) (an area of existing trees, which is to remain protected and preserved) as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Temporary Orange Construction Fence. Temporary orange Construction fence shall conform to 32 31 23.10, (Temporary Orange Construction Fence).

B. Chain Link Fence. Chain link fence for Tree Protection fence shall conform to AASHTO M181 and shall be two inch (2″) mesh woven from coated number nine (9) gauge wire.

C. Wire Mesh Fence. Wire Mesh fence shall conform to ASTM A-116 and shall be one inch (1″) farm grade with standard six inch (6″) graduated spacing with Class 1 zinc coating.

PART 3 EXECUTION

A. The Contractor shall erect a Tree Protection fence around the TPA at locations specified in the Contract Documents.

B. The Contractor, the City's Tree Protection Expert representative and the Engineer shall meet on the site to discuss all aspects of tree protection and maintenance prior to the commencement of any Work.

C. Tree Expert. The Contractor shall engage a Maryland licensed tree expert to perform the following Work:

1. Recommend procedures to compensate for loss of roots (if any) and perform initial pruning of branches and stimulation of root growth where warranted. This Work shall be completed prior to commencing any Construction activities.
2. Inspect all trees at the completion of Construction and perform follow-up care for any damage incurred.
3. Submit a written tree protection certification that the trees have been protected during the course of Construction in conformance with recognized standards of the industry. Certify that damaged trees were promptly and properly treated. Indicate any damaged trees that are incapable of reaching maturity and those recommended for removal and replacement.

D. Protective Fencing. Protective fencing shall be installed to clearly define the protected area as indicated on the Contract Documents. Prior to commencing with clearing and grubbing or erosion and sediment control, install tree protection fence around areas specified in the Contract Documents. Tree protection fence shall encompass any significant trees to be saved within and along the area designated as the TPA. The location of the tree protection fencing shall be approved on site by the tree expert and the Engineer and Baltimore City Tree Protection Expert.

E. Washout Area. Any "wash-out" area for trucks shall be located away from TPA as approved by the Engineer. No drainage from the washout area may enter the TPA.

F. Tree Roots. The Contractor shall protect tree root systems throughout the life of the project. Tree root systems shall be protected from smothering, flooding, excessive wetting resulting from dewatering operations, off-site runoff, spillage and drainage of solutions containing materials that could be hazardous to tree roots. Removal of topsoil or root mat within the TPA is prohibited.

G. Traffic. The Contractor is prohibited from parking any Construction equipment or from storing building supplies or material within the TPA. Foot traffic and vehicular traffic are prohibited within the TPA.

H. Tree Removal and Damaged Trees. The Contractor shall not remove any tree that is designated for preservation. Any tree damaged or destroyed within the TPA shall be the responsibility of the Contractor. The Contractor shall avoid the following:

1. Placing backfill in protected areas.
2. Felling trees into protected areas.
3. Driving Construction equipment into or through protected areas.
4. Burning in or in close proximity to protected areas.
5. Stacking or storing supplies in protected areas.
6. Changing site grades, which cause drainage to flow into, or to collect in, protected areas.
7. Conducting unauthorized trenching operations in the vicinity of trees.
8. Grading in the vicinity of trees.

I. Failure to comply with item A through H above will result in fines as specified in Article 7, Division IV, Forest and Tree Protection, Baltimore City Code.

J. Work within the TPA.

1. Root Pruning. The Contractor shall use a trenching machine, vibratory knife or rock saw to a depth of eighteen inches (18″) along the outside limits of disturbance, as shown in the Contract Documents, in the vicinity of existing trees prior to clearing and grubbing. When a trenching machine is used, the trench shall be immediately backfilled. This root pruning operation shall occur concurrently with tree pruning and tree fertilization.

    a. Some trees that are immediately adjacent to the root pruning may be affected adversely due to their close proximity to the excavation. Removal of any of these additional trees or any of their limbs shall require the concurrence of the Tree Protection Expert representative and the Engineer.

2. Upon satisfactory completion of these activities, protective fencing shall be installed along the outside edge of the trench line in conformance with Specifications in the Construction documents.

3. Replacing Damaged Trees. Existing trees that have been designated to remain but are damaged beyond repair due to Construction operations, as determined by the Engineer and Tree Protection Expert, shall be removed and replaced at no additional cost to the City. Replacement trees shall be the same genus, species, variety and size as the removed tree, except those trees having caliper greater than six inches (6″) shall have smaller trees furnished and installed. Caliper shall be measured as specified in 31 13 13.03, Part 4, (Selective Tree Felling). The replacement trees shall be a caliper and quantity acceptable to the Engineer and Tree Protection Expert. The minimum caliper shall be three inches (3″). Price adjustments for replacing trees with smaller caliper trees will be as specified in Part 4. Planting of replacement trees shall be in conformance with 32 90 00.01, (Planting Trees, Shrubs, Vines and Seeding Stock) and include a one (1) year warranty period.

4. Repairing Tree Limbs, Branches, and Trunks. The Contractor shall repair limbs and branches that have been damaged by Construction operations as determined by the City Arborist and Engineer. Repairing shall be accomplished by cutting damaged limbs and branches to healthy wood in conformance with 31 13 16, (Selective Tree Trimming) and this Specification at no additional cost to the City.

5. Pruning Trees. All pruning shall be in conformance with the current edition of the National Arborist Association Standard for Pruning Shade Trees, 31 13 16, (Selective Tree Trimming) and this Specification. All pruning tools and methods employed shall be in conformance with accepted arboricultural practices performed by competent personnel under the direct supervision of the tree expert. The Contractor shall notify the Engineer ten (10) days prior to the beginning of any Work. Safety ropes shall be used to climb trees to be pruned. Climbing spurs are prohibited. Existing injuries to bark, trunks and limbs as designated by the Engineer and City Arborist, shall be repaired by properly cutting, smoothing the wood if necessary, tracing the bark to the proper shape to ensure rapid healing and using only approved tools, materials and methods. All pruned material shall be removed and disposed of by means acceptable to the Engineer. The Contractor shall be responsible for all damage or injury to property of any character during the execution of the Work resulting from any act, omission, neglect or misconduct in the manner or method of executing this Work satisfactorily.

K. Construction Activities within the TPA. If Construction activities become necessary within the TPA, the Contractor shall obtain written permission from the Engineer and Tree Protection Expert prior to working in the area.

L. Removal and Clean up.

1. Removal. After Construction has been completed, protective fencing and all surplus Construction materials shall be removed from the site in a manner that will not cause damage within the TPA.
2. Clean up.

    a. The Contractor shall clean up all Work areas.
    b. Grades shall be restored, stabilized, and blended into the adjacent areas.
    c. The Contractor shall haul away all debris, excess dirt and Construction materials and dispose of off-site.

d. The Contractor shall seed all disturbed areas within twenty-four (24) hours in conformance with 32 92 23.01, (Turf Establishment).
e. The Contractor shall guard and protect the Work to prevent vandal damage.

PART 4 MEASUREMENT AND PAYMENT

A. Tree preservation, including the services of a Maryland licensed tree expert, will not be measured but the cost will be incidental to the Clearing and Grubbing item.

B. Tree Protection Fence will be measured and paid for based on Contract Unit Price per linear foot for the actual number of linear feet measured to the centers of end posts.

C. Price Adjustment. If smaller trees are furnished and installed to replace larger trees that have been damaged beyond repair as determined by the Engineer, a reduction of the Contract Price will be made at a rate of two hundred dollars ($200.00) per inch of caliper differential between the damaged tree and the smaller tree for calipers over twelve inches (12″).

31 13 13.02 SELECTIVE THINNING AND TREE PROTECTION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the selective thinning and disposing of undesirable live and dead trees, shrubs and vegetation, selective pruning of trees to be saved, and removing and disposing of windfalls, logs, stumps and rubbish as specified in the Contract Documents or as directed by the Engineer and in conformance with the Maryland Department of Natural Resources Roadside Tree Law. This Work may also consist of root pruning, mulching, deep root fertilization or other Work to preserve trees to be saved during Construction.

PART 2 PRODUCTS

2.1 MATERIALS

A. Furnished Topsoil. Refer to 31 14 13.24, Part 2, (Topsoil).

B. Herbicide. Refer to 32 92 23.01, Part 2, (Turf Establishment).

C. Marking Dye. Refer to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

3.1 EQUIPMENT

All pruning tools and tree protection devices used shall conform to the accepted arboricultural practices and as approved by the Engineer or Tree Protection Expert.

3.2 OPERATION

A. A Roadside Tree Care Permit shall be obtained from the Maryland Department of Natural Resources for all tree thinning. All Work shall be performed by personnel under the supervision of a Maryland Licensed Tree Expert and according to the most current edition of ANSI-2133 Safety Requirements. The Contractor shall notify the Engineer ten (10) days prior to the beginning of any selective thinning Work. Where Work occurs in City parklands, the Contractor shall also obtain approval from the City Arborist or their representative prior to beginning Work.

B. All selective thinning shall be completed before any new planting is performed in selective thinning areas as directed by the Engineer.

C. Growth to be removed will be as marked by the Engineer or the Tree Protection Expert where Article 7, Division IV of the City Code applies. Dead wood in shrubs shall be removed as determined by the Engineer or Tree Protection Expert where Article 7, Division IV City Code applies. Trees shall be pruned by removing all branches and stubs up to fifteen feet (15′) high. Trees and shrubs to be saved shall not be harmed by the Contractor. Injuries to bark, trunks and limbs shall be repaired by properly cutting, smoothing, tracing the bark and painting as directed by the Engineer. Where the project must comply with Article 7, Division IV, Forest and Tree Conservation, fines may be applied.

D. When undesirable growth is removed, it shall be cut as nearly flush with the ground surface as feasible. Trees, which cannot be felled without danger to traffic or injury to other plants or property, shall be cut in sections from the top down.

E. In open areas where mowing is to be performed, stumps shall be completely removed to a minimum of twelve inches (12″) below the ground surface. The stump hole shall be backfilled with approved topsoil to the height of the adjacent ground surface and seeded as specified in 32 92 23.01.

3.3 HERBICIDE APPLICATION

A. Where re-growth from stumps is not desired, basal application, selective foliage application or stump treatment may be used. This mixture shall be applied the same time the plant is cut.

B. The herbicide shall be mixed and used as directed by the Engineer or Tree Protection Expert and in conformance with the manufacturer’s recommendations.

C. All herbicide applications shall be performed as specified in the Maryland Pesticide Applicator’s Law and in conformance with the manufacturer’s recommendations. Herbicide applications shall be performed under the supervision of a Certified Applicator of Pesticides (Category III A or VI).

3.4 REMOVAL AND DISPOSAL

All trimmings, dead wood, windfalls, logs, stumps and rubbish shall be removed and disposed of by the Contractor, as directed by the Engineer.

3.5 SITE RESTORATION

When selective thinning in an area has been completed, the area shall be thoroughly cleaned. Existing turf areas that have been injured by the Work shall be re-graded and seeded, sodded or mulched and the entire area shall be neat and clean as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

Selective Thinning will be measured and paid for at the Contract Unit Price per acre. The payment will be full compensation for all herbicide, wound dressing, stump removal, backfill, site restoration and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. Outer measurements will be taken from the drip line of the forest canopy.

31 13 13.03 SELECTIVE TREE FELLING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of felling trees as specified in the Contract Documents or as directed by the Engineer and in conformance with the Maryland Department of Natural Resources Roadside Tree Law.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 EQUIPMENT

Refer to 31 13 16, Part 3, (Selective Tree Trimming)

3.2 OPERATION

A. A roadside tree care permit shall be obtained from Maryland Department of Natural Resources prior to any tree felling operations. All Work shall be performed by personnel under the supervision of a Maryland Licensed Tree Expert. Tree felling operations are:

1. Operation 1 shall consist of felling and removal of trees in mowed areas. The stump shall be removed or ground to a minimum depth of eight inches (8″) below the ground surface. The stump hole shall be backfilled level with the adjacent ground surface using approved topsoil and seeded and mulched as specified in 32 92 23.01, (Turf Establishment). All wood debris shall be removed from the site and disposed of by the Contractor.
2. Operation 2 shall consist of felling and removal of trees in areas to be cleared and are not mowed. The trees shall be felled and the stumps shall be cut to a

maximum height of four inches (4″) above the ground surface. All wood and debris shall be removed from the site and disposed of by the Contractor.

3. Operation 3 shall consist of felling trees to prevent damage to adjacent trees and structures. The trees shall be felled in such a way to prevent damage to other trees in the forest. The stumps shall be cut to a maximum height of four inches (4″) above the ground surface. All branches on felled trees extending 3 ft or more above the ground surface shall be cut off. Removal of the felled trees will not be required but all cut branches and woody material must be removed in a way to prevent damage to the forest.

PART 4 MEASUREMENT AND PAYMENT

A. Selective Tree Felling will not be measured but will be paid for at the Contract lump sum price. The Contractor shall submit a breakdown tabulation within ten (10) days after the Notice to Proceed. The Contractor's breakdown shall list each selective tree felling operation specified in the Contract Documents with a tabulation of the numbers and sizes of trees included in the lump sum price. The total of the individual units shall equal the lump sum price. In the event of a change in the number of trees included under this item, payment will be adjusted on the basis of the Contractor's breakdown of the lump sum price.

B. The size designation, under which each selective tree felling operation is performed, will be determined in conformance with the Tree Size Designation Table specified in 31 13 16, Part 4, (Selective Tree Trimming). The caliper of a tree shall be the diameter at breast height measured four and one-half feet (4-1/2′) above the ground.

C. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

31 13 16 SELECTIVE TREE TRIMMING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of selective tree trimming as specified in the Contract Documents or as directed by the Engineer and Tree Protection Expert, and in conformance with the Maryland Department of Natural Resources Roadside Tree Law.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 CONSTRUCTION

A. Equipment. All pruning tools used shall conform to the accepted arboricultural practices and as approved by the Baltimore City Arborist.

B. Operation. All Work shall be performed by personnel under the supervision of a Maryland Licensed Tree Expert. A roadside tree care permit shall be obtained from the Maryland

Department of Natural Resources prior to performing any tree pruning and approval must be received by the Baltimore City Arborist.

C. All pruning shall conform to the current edition of the American National Standards Pruning Standards (ANSI-300) ANSI-02133.1 Safety Requirements (Department of Recreation and Parks). The kind (i.e. crown thinning etc.) of tree trimming to be performed will be identified in the Contract Documents. Pruning shall be performed to the satisfaction of the Baltimore City Arborist.

D. All wood, branches and debris shall be removed as directed by the Engineer and disposed of by the Contractor.

PART 4 MEASUREMENT AND PAYMENT

A. Selective tree trimming will not be measured but will be paid for at the Contract lump sum price. In the event of a change in the number of trees included under this item, payment will be adjusted on the basis of the Contractor's breakdown of the lump sum price. This breakdown shall be submitted by the Contractor to the Engineer within ten (10) days after the Notice to Proceed. The Contractor's breakdown shall list each class of selective tree trimming specified in the Contract Documents with a tabulation of the numbers and sizes of trees included under each class of tree trimming and the individual prices for each unit included in the lump sum price. The total of the individual units shall equal the lump sum price.

B. The size designation under which each class of selective tree trimming is performed will be determined in conformance with the following schedule of pay sizes. The caliper of a tree shall be the diameter at breast height measured four and one-half feet (4-1/2') above the ground.

TREE SIZE DESIGNATIONS	
TREE CALIPER INCHES	**PAY SIZE INCHES**
under 10	6
10+ to 18	14
18+ to 26	22
26+ to 34	30
34+ to 42	38
42+ to 46	44
over 46+	50

C. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work

31 14 00 EARTH STRIPPING AND STOCKPILING

31 14 13.24 TOPSOIL AND SUBSOIL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of salvaging topsoil and subsoil, placing salvaged topsoil and subsoil and placing furnished topsoil and subsoil as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Salvaged Topsoil. Salvaged topsoil shall be that surface material to be salvaged from the project which has been classified as topsoil as specified in the Contract Documents.

B. Furnished Topsoil. Furnished topsoil shall be natural, friable surface soil uniform in color and texture and not supplied from the project. Topsoil shall be free from any parts of Johnson grass, Canada Thistle, or Phragmites. Topsoil shall have an organic content between one point five to ten percent (1.5% to 10.0%) by weight when tested as specified in T 194. Furnished topsoil shall have a corrected pH value of not less than six (6.0) nor more than seven point five (7.5).

1. Grading analysis shall be as follows:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2 inch	100
No. 4	90
No. 10	80

2. Topsoil shall be analyzed for sand, silt, and clay as specified in T 88. Textural analysis shall be as follows:

SOIL PARTICLE SIZES mm	PERCENT PASSING BY WEIGHT
Sand (2.0 – 0.050)	20 – 75
Silt (0.050 – 0.002)	10 – 60
Clay (less than 0.002)	5 – 30

C. Salvaged Subsoil. Salvaged subsoil shall be material salvaged from the project that has been classified as subsoil as specified in the Contract Documents.

D. Furnished Subsoil. Furnished subsoil shall be natural, friable subsurface soil uniform in texture and not salvaged from the project. Subsoil shall be free from any parts of Johnson grass, Canada Thistle, or Phragmites. The Contractor shall submit a source of supply for the material to the Engineer for approval, prior to use. Material shall conform to 31 23 16.12, Part 2, (Select Borrow Excavation) with the following exceptions:

1. The use of recycled portland cement concrete or recycled HMA pavement is prohibited.
2. The corrected pH value shall be five to seven point five (5.0 to 7.5).
3. The organic matter content shall be one tenth to five percent (0.1% to 5.0%).

   a. Grading analysis shall be as follows:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2 inch	100
No. 4	85
No. 10	60

   b. Material shall be analyzed for sand, silt and clay as specified in T 88. The textural analysis shall be as follows:

SOIL PARTICLE SIZES mm	PERCENT PASSING BY WEIGHT
Sand (2.0 – 0.050)	20 – 85
Silt (0.050 – 0.002)	10 – 60
Clay (less than 0.002)	5 – 40

E. Agricultural Limestone. Refer to 32 92 23.01, Part 2, (Turf Establishment).

F. Miscellaneous Landscaping Items. Refer to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

3.1 GENERAL

When soil or weather conditions are unsuitable, the Contractor shall cease topsoil and subsoil operations until directed by the Engineer to resume.

3.2 SALVAGING TOPSOIL AND SUBSOIL

A. Evaluation. Topsoil and subsoil infested with any parts (seed, rhizomes, stolons, roots, etc.) of Johnson grass, Canada Thistle or Phragmites will be evaluated by the Engineer prior to the salvaging operations to determine the severity of the infestation. The evaluation will determine how the topsoil and subsoil are to be used and to establish a means of preventing the spread of these weeds.

B. Removal. Topsoil and subsoil shall be removed from selected areas specified in the Contract Documents or as directed by the Engineer. Prior to removing topsoil and subsoil, the Contractor shall mow or remove all vegetation over the areas where topsoil and subsoil are to be salvaged. Topsoil and subsoil shall be removed to the depth as directed by the Engineer. The topsoil and subsoil shall be transported and stockpiled in separate storage piles and kept separated from other materials.

C. Storage. Storage areas for topsoil and subsoil shall be constructed on well-drained land, away from live streams, and in conformance with 31 25 00.01, (Erosion and Sediment

Control). Prior to placing piles, the Contractor shall install silt fence around the perimeter of the stockpile area and maintain the silt fence until vegetation is established. Topsoil and subsoil shall be kept in neat and separate piles separated from other excavated material. The piles shall be seeded with temporary seed immediately after final shaping of the pile. Temporary seeding shall conform to 32 92 19.01, Part 2, (Temporary Seeding and Temporary Wood Cellulose Mulching).

D. Excess. Excess topsoil and subsoil will become the property of the City and any removal will require written approval from the Engineer.

3.3 PLACING SALVAGED TOPSOIL AND SUBSOIL.

A. Evaluation. The Engineer will reevaluate salvaged topsoil and subsoil infested with any parts (seed, rhizomes, stolons, roots, etc.) of Johnson grass, Canada Thistle or Phragmites prior to placing, to establish a means of preventing the spread of these noxious weeds.

B. Surface Preparation. The Contractor shall completely prepare and finish the surface of all areas to be covered with topsoil and subsoil as specified in the Contract Documents. Immediately prior to being covered with topsoil, the prepared surface shall be in a loose condition and be free from stones or other foreign material three inches (3″) or greater. When topsoil is placed on a prepared surface material that blends with the topsoil or subsoil, the Contractor shall Work the topsoil or subsoil into that material by means acceptable to the Engineer. When topsoil or subsoil will not blend with the prepared surface material, the Contractor shall roughen the surface to provide a bond for the topsoil or subsoil.

C. Loading and Hauling. Prior to the start of the hauling operations, all grass, weeds, brush, stumps, and other objectionable material shall be removed from the surface of stockpiles.

D. Placing and Spreading Topsoil. Topsoil shall be placed, spread and maintained over the areas designated to the depth, that after settlement, the completed Work shall be in conformance with the thickness, lines, grades and elevations specified in the Contract Documents. Stones and other foreign material larger than three inches (3″) shall be removed and disposed of by the Contractor. Slopes four to one to two to one (4:1 to 2:1) shall be tracked with cleated tract type equipment operating perpendicular to the slope.

E. Placing, Spreading and Compacting Subsoil. Subsoil shall be placed, spread and compacted in maximum layers of eight inches (8″) to produce a uniform firm layer of subsoil. The completed Work shall be in conformance with the thickness, lines, grades and elevations specified in the Contract Documents. Stones and other foreign material larger than 4 inches (4″) shall be removed and disposed by the Contractor. Slopes four to one to two to one (4:1 to 2:1) shall be tracked with cleated tract type equipment operating perpendicular to the slope.

3.4 PLACING FURNISHED TOPSOIL AND SUBSOIL

A. Refer to paragraph 3.3 and the following.

B. Contractor Responsibility. The Contractor shall make all arrangements and assume all responsibility for consents, agreements and payments with property owners involved in topsoil and subsoil operations.

C. City's Soil Test Reports. Limestone and soil amendments shall be added as specified in the City's soil test reports and 32 92 23.01, Part 3, (Turf Establishment).

D. Storage. If the material is stockpiled upon delivery for future use on the project, the stockpiling shall conform to paragraph 3.2C.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for the preparation of surfaces, loading, hauling, placing, supplying and spreading limestone and soil amendments, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Salvaged topsoil will not be measured but the cost will be incidental to the Contract Price for Class I Excavation.

C. Salvaged subsoil will not be measured but the cost will be incidental to the Contract Price for Class 1 Excavation.

D. Placing Salvaged Topsoil will be measured and paid for at the Contract Unit Price per square yard for the depth specified.

E. Placing Salvaged Topsoil for Grading Adjustment will be measured and paid for at the Contract Unit Price specified in the Contract Documents.

F. Placing Salvaged Subsoil will be measured and paid for at the Contract Unit Price per cubic yard.

G. Placing Furnished Topsoil will be measured and paid for at the Contract Unit Price per square yard for the depth specified.

H. Placing Furnished Topsoil for Grading Adjustment will be measured and paid for at the Contract Unit Price specified in the Contract Documents.

I. Placing Furnished Subsoil will be measured and paid for at the Contract Unit Price per cubic yard.

31 23 00 EXCAVATION AND FILL

31 23 13 SUBGRADE PREPARATION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the preparation, protection, and maintenance of the subgrade prior to the Construction of succeeding courses.

PART 2 PRODUCTS

2.1 MATERIALS

Refer to 31 23 16.12, Part 2, (Select Borrow Excavation).

PART 3 EXECUTION

3.1 GENERAL

After roadway excavation and embankments have been completed and the requirements of 31 24 13.10, (Embankment and Subgrade) are in conformance, the subgrade shall be fine graded and compacted to a minimum density of ninety-seven percent (97%) of the maximum dry density as specified in American Association of State Highway and Transportation Officials (AASHTO) T 180.

3.2 REMOVAL AND REPLACEMENT OF UNSUITABLE MATERIAL

All soft and unstable material and any other portions of the subgrade that will not properly compact shall be removed, disposed of, and replaced with suitable material and compacted.

3.3 SUBGRADE CONTROL

The subgrade surface shall be brought to line and grade and shaped to the specified cross section. Grade shall be set for subgrade control both longitudinally and transversely with fixed controls not to exceed twenty-five feet (25′) spacing. The finished subgrade shall not deviate more than one-half inch (1/2″) from the established grade. It shall be compacted and smoothed over its full width by the use of a smooth faced, steel wheeled roller approved by the Engineer or by mechanical tampers and vibratory compactors if rolling is not feasible.

3.4 BLEEDER DITCHES

The Contractor shall at all times maintain adequate open bleeder ditches along the subgrade to keep it thoroughly drained. Erosion and sediment control practices conforming to 31 25 00.01, (Erosion and Sediment Control) shall be maintained.

3.5 SUBGRADE MAINTENANCE

Maintenance of the subgrade shall be the responsibility of the Contractor. The Contractor shall take precautionary measures to prevent damage by heavy loads or equipment. Any defects or damage shall be repaired or replaced at no additional cost to the City.

3.6 SUBGRADE APPROVAL

No subsequent cover material shall be placed upon a frozen subgrade or any subgrade until it has been checked and approved by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

Subgrade preparation, including bleeder ditches and any mechanical tamping will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

31 23 13.10 LIME TREATED SUBGRADE

PART 1 GENERAL

1.1 DESCRIPTION

This item shall consist of a treated subgrade composed of an intimate mixture of soil, agricultural lime and water uniformly mixed, compacted, shaped and cured in accordance with these Specifications to the line, grade, thickness and cross sections as shown on the Plans.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lime for soil stabilization shall be quicklime or hydrated conforming to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M 216. Hydrated lime for soil stabilization shall have a minimum combined calcium oxide and magnesium oxide content of sixty-five percent (65%) when tested as specified in C 25 and shall conform to the following gradation:

SIEVE SIZE	PERCENT RETAINED max
3/8 inch	0
No. 30	3
No. 200	25

B. Quicklime shall have a combined calcium oxide and magnesium oxide content of seventy-five percent (75%) minimum and a gradation of one hundred percent (100%) passing the three-eighths inch (3/8″) sieve when tested as specified in C 25.

C. Water shall be reasonably clean and free of oil, alkali, sugar, vegetable, or other deleterious substances. Where the source of water is relatively shallow the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign matters. Water will be tested in accordance with and shall meet the suggested requirements of American Association of State Highway and Transportation Officials (AASHTO) T-26. Water known to be potable quality may be used without test. Water containing not more than one percent (1%) salt may be used for mixing if tests prove compliance with paragraph 5 of American Association of State Highway and Transportation Officials (AASHTO) Designation: T-26.

D. Emulsified asphalts shall conform to M 140 or M 208 with the following exceptions:

1. Cement mixing tests are waived.

2. Grade SS-1 viscosity shall be fifty to four hundred (50 to 400) seconds at seventy-seven degrees (77°) F.
3. Maximum of three percent (3.0%) by volume of oil distillate.
4. The sieve test requirement for field samples shall be a maximum of four-tenths percent (0.4%).

PART 3 EXECUTION

A. Equipment: Lime-treated subgrade may be constructed with any combination of machines or equipment approved by the Engineer that will produce the results meeting the requirements for soil pulverization, lime application, mixing, water application, incorporation of materials, compaction, finishing and curing as controlled by these Specifications.

B. Preparation of Subgrade: Prior to the other Construction operations under this section, the subgrade shall be graded and shaped to conform to the lines, grades, thicknesses and cross sections required for the completed subgrade. However, compaction of the roadbed for the depth of the material to be treated will not be required prior to application of lime.

C. Pulverizing: The prepared subgrade shall be sacrificed to the depth and width required for the subgrade treatment. The material thus obtained shall be partially pulverized. The depth of scarification shall be carefully controlled and blading operations conducted in a manner to provide that the surface of the roadbed below the scarified material shall remain undisturbed and shall conform to the established cross section. Prior to beginning stabilization Work, all existing unsuitable material and stones retained on a three inch (3″) sieve shall be removed and replaced with suitable material complying with the special provisions and 31 24 13.10, (Embankment and Subgrade).

D. Lime Application: Except by specific written authorization, lime-treated subgrade shall not be constructed from November 16th to March 15th inclusive, nor shall lime application continue when the air temperature in the shade and away from artificial heat is less than forty degrees (40°) F. The quantity of lime to be used will be pre-determined and specified in the Proposal. Lime may be applied to the partially pulverized material as slurry or in dry form. When quicklime is used in a dry form it shall be applied at the same rate as hydrated lime.

E. Where quicklime is slaked on the project to produce slurry, measurement will be calculated as indicated herein for each truckload using the certified lime purity for the load. No measurements will be made of any lime added or replaced for corrective measures during Construction or for repairing damaged areas.

A = Certified weight of quicklime delivered X % purity X 1.32
B = Certified weight of quicklime delivered X % inert material
A + B = Total hydrated lime produced (pay quantity)

F. Lime applied by slurry application shall be mixed with water in approved agitating equipment and applied to the roadbed as a thin water suspension or slurry. The dispensing equipment shall provide continuous agitation from the mixing site until applied to the roadbed. The proportion of lime shall be such that the “Dry Solids Content” shall be at least thirty percent (30%) by weight. A lower percent solid may be authorized by the Engineer provided a uniform suspension of the slurry can be maintained. A weight and purity certification shall accompany each shipment of quicklime to be used in slurry applications

G. Spreading equipment shall uniformly distribute the lime without excessive loss. No equipment except water trucks and equipment used for spreading and mixing shall be permitted to pass over the spread lime until it is mixed. Spread lime that has been displaced shall be replaced before mixing is started.

H. When a stationary mixer is used to mix aggregate material, the lime may be added to the mix by an approved feeder.

I. Addition of Water: Water may be added to the mixture of lime and subgrade material by means of pressure water distributors or by means of a traveling plant. Water shall be added during mixing operations to provide moisture content equal to the optimum moisture content of the mixture plus or minus two percent (2%).

J. Mixing: T he lime and water shall be thoroughly mixed throughout the scarified material. The mixture shall then be placed in a window or spread over the roadbed and the surface sealed with a steel-wheeled or pneumatic roller to retard the loss of moisture, and aged for a period of not less than forty-eight (48) hours. After the designated period, water shall be added and the mixture brought to the optimum moisture content plus or minus two percent (±2%). Curing will be considered completed when a uniform material is produced in which at least sixty percent (60%) of the material, exclusive of aggregates, will pass the No. 4 sieve. When a stationary mixer is used, the material may be placed, compacted, and finished immediately after mixing. When traveling plants are used, additional mixing with blades, tillers, discs, harrows or repeated passes of the plant may be required. During the interval of time between application and mixing, lime that has been exposed to the open air for six (6) hours or more, or lime that has been lost because of washing or blowing, will not be measured for payment.

K. Compaction and Finishing: After the materials have been satisfactorily mixed, the mixture shall be laid and compacted to a density of not less than ninety-five percent (95%) of the maximum density determined in accordance with American Association of State Highway and Transportation Officials (AASHTO) T-99. Light sprinkling may be required during laying operations to maintain the specified moisture content. In place density tests will be made in accordance to Maryland Standard Method of Tests (MSMT) 350 or 352. The surface shall be lightly scarified during finishing operations and bladed to eliminate any imprints left by the equipment. Final rolling of the completed subgrade shall be accomplished with pneumatic tire roller. Final compaction and finishing shall be completed within twelve (12) hours after final mixing.

L. Smoothness and Thickness Tolerance: String line and grade must be set, for subgrade control, on each side of the proposed roadway paving with fixed controls not to exceed twenty-five foot (25′) spacing. Finished subgrade must not deviate more than one-half inch (1/2″) from grade thus established. Areas that are deficient in thickness by more than one inch (1”) shall be removed or reworked with additional amount of lime equal to 50 percent (50%) of the original amount. In the case of stabilized based courses, the Contractor may correct sections deficient in depth by applying hot mix asphalt (HMA) provided such correction is authorized by the Engineer. Areas that are excessive in thickness by more than two inches (2″) shall be reworked and an amount of lime equal to fifty percent (50%) of the original amount added to the mixture. Replacement and corrective Work shall be at the Contractor’s expense.

M. Protection and Curing: Upon completion of the compaction and finishing of the treated subgrade, no vehicles or equipment other than sprinkling equipment shall be permitted on

the treated subgrade for a period of seven (7) days unless otherwise directed. During the curing period the treated subgrade shall be lightly sprinkled with water at frequent intervals to prevent drying. The Contractor shall plan and prosecute the Work in such a manner as to place the next course during the curing period. If the Contractor has not placed the next course by the end of the curing period, it shall apply emulsified asphalt and cover material at the rate of two-tenths (0.2) gal/sqyd unless otherwise specified on the Plans.

N. Maintenance: The Contractor shall be required, within the limits of its Contract, to maintain the lime-treated subgrade in good condition until all Work has been complete and accepted. Maintenance shall include immediate repairs of any defects that may occur. This Work shall be done by the Contractor at its own expense and repeated as often as may be necessary to keep the area continuously intact. Faulty Work shall be replaced for the full depth of treatment. Any low areas shall be remedied by replacing the material for the full depth of treatment rather than by adding a thin layer of lime treated subgrade to the completed Work.

PART 4 MEASUREMENT AND PAYMENT

A. The measurement of the manipulation of lime-treated subgrade shall be the number of square yards complete in plan, determined by surface measurements of completed base course as indicated on the Plans.

B. Lime for lime-treated subgrade shall be measured on the basis of the actual number of tons used. In no case will the amount approved for payment be greater than one hundred five percent (105%) of the theoretical amount required based on the number of square yards as measured above, the maximum dry density of the mixture and the lime content as determined by the Engineer.

C. Soil will be measured under the pertinent class of excavation.

D. The Work shall be paid for at the Contract Unit Price per square yard for lime-treated subgrade complete in place, which price shall be full compensation for mixing, watering, compacting and finishing of the item, and for labor, tools, equipment and incidentals necessary to complete the item and all materials, except soil and lime. Soil will be paid for under the pertinent class of excavation.

E. Lime for lime-treated subgrade shall be paid for at the Contract Unit Price per ton for Agricultural Lime which payment shall be made only for lime actually used as measured above. The price shall include furnishing, delivery and Work incidental for the soil lime mixing operation.

31 23 16.05 TEST PIT EXCAVATION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of excavation and backfilling for test pits to determine the location of underground structures and utilities as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. It shall be the responsibility of the Contractor to determine the location of underground structures and utilities by the use of test pit excavation prior to excavation operations.

B. Test pits shall be of the size, depth and location as authorized by the Engineer. Each pit shall be backfilled as specified in 31 23 23.10, (Tamped Fill).

PART 4 MEASUREMENT AND PAYMENT

Test Pit Excavation will be measured and paid for at the Contract Unit Price per cubic yard for the material actually removed from within the limits specified. The payment will be full compensation for all excavation, tamped backfill and all material, labor, equipment, tools, and incidentals necessary to complete the Work. Any pavement to be replaced will be measured and paid for as specified in 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavement) and 32 13 13.43, (Continuously Reinforced Portland Cement Concrete Pavement).

31 23 16.10 ROADWAY EXCAVATION (CLASS 1, CLASS 1-A, CLASS 2)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the excavation and grading for roadways and their appurtenances to the lines and grades specified in the Contract Documents. The Contractor shall use all suitable materials from excavation in the Construction of embankments throughout the limits of the Work as directed by the Engineer.

1.2 CLASSIFICATION

CLASS 1 All excavation where the width of the bottom of the cut is fifteen feet (15′) or more.

CLASS 1-A All excavation of unsuitable material below the lowest excavation limits established.

CLASS 2 All excavation where the width of the bottom of the cut is less than fifteen feet (15′). Excavation for flumes, ditches, streams and channel changes are included in this classification unless otherwise specified in the Contract Documents.

1.3 EXCAVATION

A. Excavation shall include the following:

1. Cut areas within the boundary faces of the typical cross sections specified in the Contract Documents, including ditches within the cut sections, and excavation for

entrances, approach roads, streets, intersections, gutters, ditches, berm ditches, and flumes.

2. Topsoil to be salvaged within the limits of excavation as specified in the Contract Documents or as directed by the Engineer.
3. The removal and disposal of existing pavement, sidewalks, curb and combination curb and gutter, when within the limits of any class of excavation. The Work shall be as specified in 02 41 13.16, (Removal of Existing Pavement, Sidewalk, Paved Ditches, Curb or Combination Curb and Gutter).
4. The removal and disposal of below grade structures other than as specified in 02 41 16.13, (Building Demolition and Disposal) or 02 41 13.14, (Minor Selective Site Demolition).

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 GRADING UNITS

A. Each grading unit shall be the surface area of erodible earth that can be exposed to Construction operations without undue erosion or sedimentation. The size and number of these units that can be opened at one (1) time shall conform to the following:

1. Unless otherwise specified in the Contract Documents or as directed by the Engineer, the clearing and grubbing area shall be limited to a twenty (20) acre grading unit per grading operation. Once this first unit is half graded, the Contractor will be allowed to proceed with the second twenty (20) acre grading unit. With the permission of the Engineer, the Contractor will be allowed to exceed the one (1) grading unit requirement to balance earthwork or when grading interchanges. Erosion and sediment control shall conform to the Contract Documents and Section 31 25 00.01, (Erosion and Sediment Control).
2. A grading operation is defined as the Contractor's ability to provide adequate resources to perform the grading in a timely manner and provides and maintains the proper erosion and sediment control measures. The Engineer will be the final authority in this determination. A grading unit need not be twenty (20) contiguous acres. When wet soil conditions are encountered, the Contractor will be allowed to clear, grub and grade another unit providing the initial unit has been properly stabilized. No more than two (2) grading units shall be active at any time.

3.2 USE OF EXCAVATED MATERIALS

A. No excavated material shall be wasted without prior approval of the Engineer. Borrow shall not be used unless provisions have been made for utilizing all available suitable excavated materials in embankments. Refer to 31 23 16.12, (Select Borrow Excavation).

B. The Contractor, with the approval of the Engineer may use on the project any excavated stone, gravel, sand or other material conforming to the requirements of the Contract Documents.

C. When these materials are used for select, capping, modified, or common borrow and conform to the pertinent materials Specifications, payment will only be made at the Contract Unit Price for the class of excavation from which the materials are obtained.

D. In the event these materials are processed through a crushing, screening, washing or sorting plant for use as another pay item, the Contractor will be paid both for the excavation of such materials at the Contract Unit Price and at the Contract Unit Price for which the material is used.

E. If however, these materials are not processed and paid for as described in the preceding paragraph, and their use creates a shortage of embankment, backfill, approaches or other material, the Contractor shall provide acceptable replacement material for all the material needed for embankments, backfills, approaches or otherwise. In this case, the replacement material shall be paid for at the unit price for the item the Class 1 excavation is used for, or the unit price Bid for the Class 1 excavation, whichever is the lower unit price Bid.

F. The Contractor shall not excavate or remove any material that is not within the limits of excavation, as indicated by the slope and grade lines, without written authorization from the Engineer.

3.3 BROKEN PAVEMENT MATERIAL

Existing pavement, sidewalks, gutter, curb or combination curb and gutter materials from the excavation may be broken and used in embankments. The broken material shall be considered as rock providing that individual pieces do not exceed of twenty-four inches (24″) in any dimension and larger size rocks may be wasted with the approval of the Engineer. If the Engineer considers the material to be unsuitable, it shall be disposed of as excess or unsuitable material.

3.4 ROCK EXCAVATION

A. Boulders and Rock

1. Boulders and rock from the excavation may be broken and used in embankment provided the materials conform to the following:

   a. Rock may be used in embankments, provided that individual pieces do not exceed twenty-four inches (24″) in any dimension. Larger size rocks may be wasted with the approval of the Engineer.

B. Blasting

Where rock encountered during cuts requires drilling and blasting, the finished slope shall remain reasonably straight and clean. The Contractor shall adjust blasting operations to obtain the required slope specified in the Contract Documents.

C. Presplitting

1. When presplitting of rock slopes is specified in the Contract Documents, the presplitting operation shall be carried out prior to the primary blasting so knowledge gained from excavation of the presplit face may be applied to subsequent presplitting operations. No portion of any primary blast hole shall be drilled closer than half the spacing of the drilling pattern to the proposed finished slope.

2. The Contractor shall submit a plan for the proposed presplitting operations to the Engineer for approval. The plan shall include the drill size, lift height, explosives and detonator Specifications, loading pattern, stemming materials, stemming depth, charge size, and charge timing.
3. The initial presplit shot shall not be longer than one hundred feet (100′). The Contractor shall drill holes along the slope line having a diameter of two to three inches (2″ to 3″). Drill holes shall be placed at the slope angle as specified in the Contract Documents. All drill holes shall maintain the same plane. The initial presplit holes shall be drilled on maximum three feet (3′) centers and to a maximum depth of twenty feet (20′) unless otherwise directed by the Engineer. If the vertical depth of cut to be presplit is greater than the maximum permissible depth of holes as determined by the Engineer, the blasting shall be done in two (2) or more lifts; in which case the first line of drill holes shall be set back a sufficient distance from the slope line to allow for a one foot (1′) offset for each succeeding line of drill holes.
4. The Contractor shall excavate the initial presplit shot for inspection by the Engineer prior to commencement of further presplitting. If the results are approved by the Engineer, the presplitting may continue using the approved drilling and loading pattern. Whenever the presplitting is found to be unsatisfactory, the Contractor shall make adjustments in the operations and repeat the inspection procedure used for the initial presplit shot.
5. The presplit face shall be within six inches (6″) from the front of the line of drill holes and one foot (1′) from the back of the line of drill holes except where the character of the formation being presplit (badly broken rock, vertical seams, etc.) will result in irregularities.
6. The line of presplit holes shall extend a minimum of thirty feet (30′) beyond the limits of the primary blast holes to be detonated or to the end of the cut.
7. Only cartridge explosives manufactured for presplitting shall be used. The maximum diameter of explosives used in presplit holes shall be half the diameter of the presplit hole. Bulk explosives are prohibited in presplit holes.
8. The Engineer may direct the discontinuance of the presplitting operations wherever the rock is of a character that no apparent advantage is gained.

3.5 FROZEN MATERIAL

Frozen material is prohibited from being placed in embankments. It shall be stockpiled outside the Construction limits and reserved for future use. Any material that is wasted shall be replaced. Rehandling of excavated material and replacement of wasted material shall be at no additional cost to the City.

3.6 SERRATED SLOPES

Serrated cut slopes are defined as slopes having continuously benched faces. Slopes that are to be serrated and the width and height of benches shall be as specified in the Contract Documents or as directed by the Engineer. The benches shall be constructed parallel to each other, and they shall be level, not graded to drain, and shall be constructed as the excavation progresses.

3.7 DRAINAGE

All drainage shall conform to 31 25 00.01, (Erosion and Sediment Control). During Construction of the roadway, the roadbed shall be maintained in a well-drained condition at all times. Excavated material is prohibited from being deposited or left within three feet (3′) of the edge of the ditch or channel or be permitted to obstruct normal surface drainage into the ditch or channel. Ditches draining from cuts to embankments or otherwise shall be constructed to avoid damage to embankments by erosion. All drainage necessary to provide free and uninterrupted flow of the surface and underground water shall be installed before surfacing is placed. When stabilized side and outlet ditches provide the principal means for drainage, the cutting and stabilization of ditches for the disposition of surface water shall be the first Work in the grading operation.

3.8 EXCAVATION BEYOND SPECIFIED LIMITS

A. The widening of cut or excavation sections beyond the limits of the typical cross section as specified in the Contract Documents is prohibited except by written authorization from the Engineer. When authorized by the Engineer the procurement of additional materials for embankments, unless otherwise specified under 31 23 16.12, (Select Borrow Excavation), shall conform to the following:

1. Finished Excavation. The widening of cuts or excavation sections shall be finished so that completed flat and slope areas shall be uniform in appearance. The slopes shall not be steeper than the cut slopes specified in the Contract Documents or as directed by the Engineer.
2. Roadway Excavation Limits.

    a. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed, prior to the starting of roadway excavation in a cut section, all material within the limits will be classified as Class 1 Excavation.
    b. If the Contractor, with approval of the Engineer, elects to obtain material by widening cuts beyond the limits of the typical cross section originally proposed and within the right-of-way or easement, the excavation of the materials will be classified as Class 1 Excavation.

3. Borrow Excavation 31 23 16.12, (Select Borrow Excavation) Beyond Specified Limits.

    a. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed after the Contractor has substantially completed the roadway excavation in a cut section, all material removed beyond the limits of the typical cross section will be classified as Borrow Excavation.

3.9 UNSUITABLE MATERIAL

A. Unstable or other unsuitable material encountered at or below the typical section specified in the Contract Documents shall be removed to the extent directed by the Engineer and classified as Class 1-A excavation. In rock areas, the limit of measurement for excavation will be at the bottom of the typical section. All voids created by the removal of unsuitable

material, except when rock is encountered at subgrade, shall be backfilled to the lines and grades with the material specified in the Contract Documents.

B. Backfill material shall conform to the following:

1. All borrow excavation shall be a soil or soil aggregate mixture and shall conform to 31 23 16.12, Part 2.1, (Select Borrow Excavation).

3.10 COAL DEPOSITS

The Contractor shall notify the Engineer when coal is encountered on any Construction project. The notice shall be sent to the Director, Bureau of Mines, Maryland Department of Natural Resources. Any coal encountered on the project shall be disposed of as directed by the Engineer.

3.11 WIDENING EXCAVATION LIMITS

The area to be excavated for widening shall be limited to the extent that the excavated area can be backfilled within the same working day using the excavated material or common borrow to form a temporary wedge. The four to one (4:1) or flatter fill slope shall be maintained. The material shall be compacted as directed by the Engineer and remain in place until placement of the graded aggregate base course.

PART 4 MEASUREMENT AND PAYMENT

A. Roadway excavation will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent Class of Excavation. The payment will be full compensation for all excavation and hauling, blasting, formation and compaction of embankments and backfills, disposing of excess and unsuitable materials, preparation and completion of subgrade and shoulders except as otherwise specified, serrated slopes, rounded and transition slopes, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. Payment will not be made for excavation of any material used for purposes other than those designated.

B. Limits of Measurement.

1. Roadway Excavation. The lower limit of measurement will be the surface upon which roadway materials, including base course, surfacing or selected capping material is to be placed in either pavement or shoulder areas.
2. Concrete Pavements. Measurement will be taken to one foot (1′) outside of the outer edge of the pavement on each side. Where concrete curb or combination concrete curb and gutter is built contiguous to the pavement, measurement for excavation will be the outer limits of the concrete curb or combination curb and gutter.
3. Rocks and Boulders. If ledge rock, scattered rock, or boulders of one-half (1/2) yd^3 or larger volume are removed, any resulting undercutting approved by the Engineer will be measured for payment.
4. Slides or Breakages. Slides or breakages not attributable to the Contractor's negligence as determined by the Engineer will be measured and included in the final quantities for Class 1 excavation.
5. Topsoil and Root Mat. Measurement will be made for the removal of topsoil and root mat when it is required to be removed from fill areas. In the case of removal

of root mat, however, Class 1 excavation shall only apply when the strata underlying the root mat are suitable for supporting embankments. If material is unsuitable for supporting embankments then removal of root mat and unsuitable material will be measured as Class 1-A excavation.

C. Excavation will always be measured in its original position. No liquids will be included in any measurement.

D. No measurement will be made for any additional excavation required to construct new curb, curb and gutter, paved ditch, paved gutter, paved flume, or sidewalk paving.

E. Template Method of Measurement: Unless otherwise specified, excavation will be computed using the template from preliminary cross sections of the original ground surface combined with templates of the typical cross sections. If this method is used, certain volumes will be excluded.

1. Excluded volumes are:

   a. Undercutting for cushion over rock.
   b. Entrances and intersections for which details are not specified in the Contract Documents and for which no quantity was allowed in the Contract Documents.
   c. Salvaged topsoil from under embankments.
   d. Removal of root mat from under embankments.

2. The template method will not be used:

   a. Where there are approved changes in design and typical sections.
   b. Where there are approved deviations from planned slope faces in rock cuts.
   c. Where the original ground conditions upon which preliminary cross sections were taken have been changed before the Contractor begins Work.
   d. For Class 1-A excavation.
   e. When the Work of the Contractor does not conform to the line, grade, or cross section specified in the Contract Documents or as changed by subsequent written authorization by the Engineer. Unless corrective action is required, payment will be based on the changed quantities as determined by the cross section method as described in the following paragraph F.

F. Cross Section Method of Measurement: When specified, quantities for payment of excavation will be computed by average end areas, from the cross sections of the original ground combined with cross sections of the completed Work. Class 1 excavation will be allowed in median areas of cut sections only where four inches (4″) or greater of topsoil are to be placed. This method will also apply to Class 1-A and Class 2 excavation unless otherwise specified

G. Presplitting will not be measured but the cost will be incidental to the Contract Unit Price per cubic yard for the pertinent class of excavation in which it occurs.

H. Removal of existing pavement, sidewalk, paved ditches, curb or combination curb and gutter within the limits of any class of excavation will not be measured but the cost will be incidental to the Contract Unit Price per cubic yard for the pertinent class of excavation in which it occurs.

I. Recomputation of Quantities: The Contractor or the City may elect to recompute quantities in any section where it is believed the planned quantities are incorrect. When recomputation reveals an error, the corrected quantity will be used.

J. The excavated material or common borrow required to fill the temporary wedge area in conformance with paragraph 3.11, maintaining the four to one (4:1) or flatter slope, compaction, and removal of the material will not be measured but the cost will be incidental to the Contract Unit Price for the pertinent class of excavation. For measurement and payment of drums refer to 34 71 13.02, (Drums for Maintenance of Traffic).

K. Backfill for unsuitable material will be measured and paid for at the Contract Unit Price for the pertinent item specified in the Contract Documents.

31 23 16.12 SELECT BORROW EXCAVATION

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing, excavating, hauling, and placing approved materials for embankments and backfills when sufficient quantities of suitable materials are not available from other excavations as specified in the Contract Documents. It shall include all Work prescribed for backfills, embankments, subgrade, and earth shoulders, all necessary clearing and grubbing, the removal and disposal of overburden or other unsuitable spoil material and the trimming, shaping, dressing, draining, and reclamation of the pit or location from which borrow material is secured.

B. No excavated material shall be wasted without prior approval of the Engineer. Borrow shall not be used unless provisions have been made for utilizing all available suitable excavated material in embankments.

C. The Contractor, with the approval of the Engineer may use on the project any excavated stone, gravel, sand or other material conforming to the requirements of the Contract Documents. When these materials are used for select, capping, modified, or common borrow and conform to the pertinent materials Specifications, payment will only be made at the Contract Unit Price for the class of excavation from which the materials are obtained. In the event these materials are processed through a crushing, screening, washing or sorting plant for use as another pay item, the Contractor will be paid both for the excavation of such materials at the Contract Unit Price and at the Contract Unit Price for which the material is used. If however, these materials are not processed and paid for as described in this paragraph, and their use creates a shortage of embankment, backfill, approaches or other material, the Contractor shall provide acceptable replacement material for all the material needed for embankments, backfills, approaches or otherwise. In this case the replacement material shall be paid for at the unit price for the item the Class 1 excavation is used for, or the unit price Bid for the Class 1 excavation, whichever is the lower unit price Bid. The Contractor shall not excavate nor remove any material that is not within the limits of excavation, as indicated by the slope and grade lines, without written authorization from the Engineer.

1.2 CONTRACTOR'S OPTIONS

A. The Contractor, as a duly authorized agent of the City, may elect one of the following three methods to obtain borrow material for use on public highway Contracts:

1. OPTION 1: Acquire material from a licensed commercial operating Supplier.
2. OPTION 2: Make application to the Department of Transportation.
3. OPTION 3: Make application to the City to operate under the standard, adopted in conformance with the Annotated Code of Maryland, Environment, Surface Mining, entitled "Exemptions." A Contractor who elects to use Option 3 shall submit an application to the City fulfilling all the requirements of the cited subtitle.

1.3 NOTICE TO CONTRACTOR—BORROW PITS

A. If the Contractor elects, a borrow pit may be established on privately owned property and the City may grant an "Exemption for a Surface Mining Permit" normally issued by the City. Before a permit can be granted, the Contractor shall submit to the City written proof that all local permits or approvals have been secured for the borrow pits.

B. The following conditions applicable to the City shall be complied with and documented for the borrow pit location.

1. COUNTIES

a. Baltimore (BA) County

1) Site Plan approved by the Department of Environmental Protection and the Soil Conservation District.
2) County Grading Permit.
3) Critical Areas approval by the Department of Environmental Protection and Resource Management (if applicable).
4) Inspection by County.

2. BALTIMORE CITY (BC)

a. Site plan approved by Baltimore City Department of Public Works (BCDPW).
b. Inspection by BCDPW.

3. STATE AND FEDERAL PROPERTY

a. Borrow pits located on state and federal property are subject to Maryland Department of the Environment approval.
b. Inspection by State Highway Administration (SHA).

C. An exemption under Option 3 will require approval of an excavation and reclamation plan along with the drainage patterns and methods of attaining satisfactory drainage and soil conservation as the Work progresses. The plan shall also provide for surface restoration suitable for the proposed subsequent land use after reclamation is completed and the proposed method of accomplishment.

1.4 BORROW PITS WITHIN 100 YEAR FLOODPLAIN

A. Borrow pits located within the one hundred (100) year floodplain of any waterway having a drainage area four hundred (400) acres or more one hundred (100) acres for Class II and IV trout streams) shall also have the Department of Natural Resources (DNR) approval. Borrow pit operations that impact either tidal or nontidal wetlands shall also be approved by DNR. Copies of the U.S. Army Corps of Engineers 404 permit or the State wetlands permit or license will be provided before an exemption will be granted.

B. The determination as to the applicability of waterway Construction or wetland permits shall be the responsibility of the Contractor.

C. If the pit is in operation and the City discovers that the Contractor is not in conformance with these regulations, the City will take the appropriate action required including Work shutdown, until the Contractor is in conformance.

PART 2 PRODUCTS

2.1 MATERIALS

A. All borrow excavation shall be a soil or soil aggregate mixture and shall conform to the following:

1. Maximum dry density and optimum moisture content of the material shall be determined as specified in American Association of State Highway and Transportation Officials (AASHTO) T 180 Method C unless the material has more than thirty-five percent (35%) retained on the No. 4 sieve, in which case Method D shall be used. Material with a maximum dry density of less than one hundred (100) lb/ft^3 is unsatisfactory and shall not be used in embankments unless otherwise specified in the Contract Documents. Potentially expansive materials, such as steel slag, shall not be used.
2. Recycled portland cement concrete or recycled hot mix asphalt (HMA) pavement may be used as select borrow, capping borrow, and modified borrow with the written approval of the Engineer. Recycled portland cement concrete, recycled HMA pavement, and processed contaminated soil shall not be used within one foot (1′) of the surface in any area to be vegetated.
3. All recycled or rehandled materials shall conform to the following: For recycled or rehandled material furnished by the Contractor for use on the project, the Engineer may require the Contractor to have the material tested and certified to be in conformance with all applicable environmental requirements. The required testing will be determined by the Engineer and may include, but not be limited to, the EPA Toxicity Characteristic Leaching Procedure (TCLP) or its successor. The evaluation and interpretation of the test data will be made by the Engineer and be based upon the project environment. Testing and certification shall be at no additional cost to the City. This does not preclude the normal materials process, and the recycle material shall conform to all applicable Specifications. Typical recycled materials are:

    a. Crumb Rubber. Any rubber derived from processing whole scrap tires or shredded tire materials from automobiles, vehicles, or other equipment owned and operated in the United States, provided the processing does not produce waste casings or other round tire material that can hold water

when stored or disposed of above ground. Rubber tire buffings produced by the retreading process qualify as a source of crumb rubber.

b. Recycled Asphalt Pavement. Existing asphalt pavement milled or otherwise removed. Recycled in-place material is excluded.
c. Glass. Waste glass crushed to be used as aggregate.
d. Blast Furnace Slag. The nonmetallic byproduct of iron production.
e. Recycled Concrete Pavement. Existing concrete pavement crushed to be used as aggregate.
f. Mining Waste Rock. The coarse material removed during the ore mining process.
g. Coal Fly Ash. Fine material collected from the stack gases after coal combustion.
h. Other. Any materials not listed above that are recycled as the original product or incorporated into other products.

B. Select borrow shall conform to material as specified in the Contract Documents. The maximum dry density shall be a minimum of one hundred five (105) lb/ft^3.

C. Capping borrow shall conform to the select borrow requirements except when material has less than ten percent (10%) retained on the No. 10 sieve, at least fifteen percent (15%) shall pass the No. 200 sieve. Sieve analysis shall be determined in conformance with MSMT 302.

D. Modified borrow shall have a minimum of fifty percent (50%) retained on the No. 4 sieve, a maximum liquid limit of thirty (30) when tested as specified in T 89, and a maximum plasticity index of nine (9) when tested as specified in T 90. The maximum dry density shall not be less than one hundred twenty-five (125) lb/ft^3. Certain material, as defined in the Contract Documents, shall not be used.

E. Common borrow shall have a maximum dry density of not less than one hundred (100) lb/ft^3.

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

Refer to 31 11 00

3.2 BORROW PIT MATERIAL

The Contractor shall notify the Engineer a minimum of thirty (30) days in advance of the opening of any borrow pit so that soil analysis, elevations, and measurements of the ground may be made. After the pit is opened, the material excavated shall be used only for the project intended. The Contractor shall not excavate additional material for other purposes until a final survey is made of the pit.

3.3 BORROW PIT AFTER EXCAVATION

The borrow pit shall conform to the Reclamation (Permit) Plan after the necessary quantity of materials has been removed. Steep slopes and sheer faces shall be avoided. All disturbed areas shall be seeded and mulched as specified in 32 91 16.16, at no additional cost to the City. Shaping and seeding requirements do not apply to commercial borrow pits.

3.4 BORROW EXCAVATION BEYOND SPECIFIED LIMITS

A. The widening of cut or excavation sections beyond the limits of the typical cross section as specified in the Contract Documents is prohibited except by written authorization from the Engineer. When authorized by the Engineer the procurement of additional materials for embankments, unless otherwise specified under Borrow Excavation, shall conform to the following:

1. Finished Excavation. The widening of cuts or excavation sections shall be finished so that completed flat and slope areas shall be uniform in appearance. The slopes shall not be steeper than the cut slopes specified in the Contract Documents or as directed by the Engineer.
2. Roadway Excavation Limits.

    a. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed, prior to the starting of roadway excavation in a cut section, all material within the limits will be classified as Class 1 excavation.
    b. If the Contractor, with approval of the Engineer, elects to obtain material by widening cuts beyond the limits of the typical cross section originally proposed and within the right-of-way or easement, the excavation of the materials will be classified as Class 1 excavation.

3. Borrow Excavation Beyond Specified Limits. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed after the Contractor has substantially completed the roadway excavation in a cut section, all material removed beyond the limits of the typical cross section will be classified as Borrow Excavation.

3.5 COMPACTION

A. Immediately after the spreading of each layer, the material shall be compacted with compaction equipment approved by the Engineer. Rolling shall be done in a longitudinal direction along the embankment, beginning at the outer edges and progressing towards the center. The travel paths of traffic and equipment shall be dispersed over the width of the embankment to aid in obtaining uniform compaction.

B. Material one foot (1′) below the top of subgrade shall be compacted to not less than ninety- two percent (92%) of the maximum dry density as specified in T 180. Material in the top one foot (1′) shall be compacted to not less than ninety-seven percent (97%) of the maximum dry density. In-place density shall be determined by Maryland Standard Method of Tests (MSMT) 350 or 352. When necessary, the layer shall be wetted or dried in order to compact the layer to the required density. The resultant moisture content of embankment material, when finally compacted to required density, shall be within two (2) percentage points of optimum.

C. The Contractor shall provide a portland cement concrete compaction block having dimensions eighteen inches by eighteen inches by nine inches (18″ X 18″ X 9″) and weighing at least two hundred pounds (200 lb). One (1), eighteen inch by eighteen inch (18″ X 18″) working face shall have a level broomed surface.

PART 4 MEASUREMENT AND PAYMENT

A. Borrow excavation will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent Borrow item. The payment will be full compensation for clearing and grubbing, furnishing, excavating and hauling, sloping, draining and reclamation of pits (if Option 2 or 3 is selected), the formation and compaction of embankments, backfills, subgrade, manipulation and additives for select borrow, all Work and materials for earth shoulders except as otherwise specified, disposing of all unsuitable spoil material, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. When requested by the Contractor in writing, the Engineer may approve an alternate method of measurement for the computations of borrow excavation quantities. This alternate method will not be considered for approval unless the Contractor can show that the cross section method computed by average end area is not a feasible method of measurement. When approved in writing by the Engineer, this alternate method shall consist of measuring the borrow excavation in approved hauling vehicles in the following manner:

1. The Contractor shall designate, prior to the start of hauling operations, the identification number of each vehicle to be used. The Engineer will determine the water level capacity of each vehicle. The measured capacity shall be multiplied by a factor of point eight five (0.85) to determine the pay volume.
2. The Contractor shall furnish a delivery ticket to the Engineer for each load of borrow material delivered to the project. Any ticket not signed by the Engineer to acknowledge receipt will not be used in the computation of the borrow quantity. The ticket shall include the following:

    a. The supplier's name.
    b. The City's Contract number.
    c. The date and ticket number.
    d. Vehicle identification number.
    e. Type of material delivered.
    f. Pay volume computed as specified in paragraph 1.

31 23 16.14 CHANNEL OR STREAM CHANGE EXCAVATION (CLASS 5)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of excavation for changes in streams and channels when specified in the Contract Documents. The Contractor shall use all suitable materials from excavation in the Construction throughout the Contract.

PART 2 PRODUCTS

2.1 MATERIALS

Refer to the applicable provisions of 31 23 16.10, (Roadway Excavation Class 1, Class 1-A, Class 2).

PART 3 EXECUTION

Refer to the applicable provisions of 31 23 16.10, (Roadway Excavation Class 1, Class 1-A, Class 2).

PART 4 MEASUREMENT AND PAYMENT

A. Class 5 excavations will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for all excavation and hauling, formation and compaction of embankments and backfill, backfilling old stream beds or otherwise disposing of excess and unsuitable materials, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Material will be measured in its original position and the volume computed by the method of average end area. The cross sectional area measured will not include liquids. Measurement for Class 5 excavation excludes any material removed outside the limits of payment as specified in the Contract Documents.

31 23 16.16 STRUCTURE EXCAVATION (CLASS 3)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of excavation and backfill for structures as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Subfoundation concrete shall be mix No. 1 with twenty-eight (28) days strength of twenty - five hundred (2500) PSI and slump range two to five inches (2″–5″).

PART 3 EXECUTION

3.1 GENERAL

All excavation contiguous to existing pavements and structures shall be sheeted, shored, braced, and supported in a substantial manner to prevent settlement, movement, or damage to the pavement or structure. Excavated material shall not be placed in any manner that may endanger any structure and shall be kept out of waterways. The Contractor will establish and operate a dewatering system as required to keep the excavation site dry and must keep Construction equipment from driving on the foundation once the foundation has been accepted by the Engineer.

3.2 BACKFILL AND EMBANKMENT MATERIAL

All suitable material removed from the excavation shall be placed in backfill or stored for future use. Excavated material shall not be wasted without permission of the Engineer. Boulders, logs or other unforeseen, unsuitable material encountered shall be removed

from excavated material prior to placing as backfill. Unsuitable material shall be disposed of in an approved disposal area.

3.3 FOOTING ELEVATIONS

The elevation for the bottom of the footing specified in the Contract Documents shall be considered as approximate only, and the Engineer may, during the period of Construction, direct changes in dimensions or elevations of footings to secure a satisfactory foundation.

3.4 FOOTING FOUNDATIONS

A. Footings for structures shall be on suitable foundations, and no concrete shall be placed or foundation piles driven, until the foundations are approved by the Engineer.

B. All rock or other hard foundation material shall be cleaned of loose material and cut to a firm surface, either level or stepped as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete will rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Final removal of the foundation material to grade shall not be made until just prior to concrete placement. When the Contract Documents include an item for subfoundation investigation, the item shall be used to verify the character of the foundation if directed by the Engineer.

C. Faces of footings shall be placed plumb against either undisturbed material, rock, sheeting, shoring, or forms. Faces of footings in rock shall bear against a minimum one foot (1′) depth of rock. If the excavation will not stand plumb, the Contractor shall furnish and install sheeting, shoring, or forms as required. When specified in the Contract Documents, sheeting used to construct spread footings shall be left in place and cut off a minimum of one foot (1′) below the existing grade, channel bottom or mud line as applicable. When not specified, or when sheeting is used to construct pile supported foundations, the sheeting may be removed. The Contractor shall dispose of all removed material to approved spoil areas.

D. The design of sheeting and shoring shall be the responsibility of the Contractor. When the material retained by the sheeting and shoring is greater than six feet (6′) high, the details, procedures, and computations shall be submitted. The Contractor shall utilize a professional engineer (P.E.) registered in the State of Maryland who has a minimum of five (5) years experience in sheeting and shoring design. The sheeting and shoring design calculations and Plans shall be signed by the P.E. and bear the seal of the P.E. The submittal of the design and Plans shall include the P.E.'s resume showing evidence of the required experience.

E. The P.E.'s Plans and design calculations shall evaluate and qualify all products and components including manufactured products and proprietary items for their intended service. Acceptance by the Engineer of sheeting and shoring systems shall not in any way relieve the Contractor of the responsibility for the safety and adequacy of the design and Construction for the sheeting and shoring systems and operations, including all components.

F. Every structure in the Construction Contract will require separate sheeting and shoring design analysis, separate Plans, and design submittal as set forth above. This applies even though structures may appear to be identical.

G. Forms used for footings shall be removed and the void between the footing and the embankment shall be backfilled with subfoundation concrete or tamped fill utilizing crusher run aggregate CR-6. The material shall be compacted to a minimum of ninety-two percent (92%) of maximum density when tested in conformance with American Association of State Highway and Transportation Officials (AASHTO) T 180, Method C. Subfoundation concrete shall be used for this backfill when footings are submerged. Footing form Working Drawings will be required for approval for footings thicker than six feet (6′) or below the water table or adjacent to railroad tracks.

H. Where foundation piles are used, the excavation of each pit shall be completed to the as planned bottom of footing elevation before the piles are driven. After the driving is completed, all loose and displaced material shall be removed, without damaging the placed piling, leaving a suitable bed to receive the footing concrete. For tremie seal, the displaced material may remain in place provided the minimum thickness of footing concrete, pile embedment and the required sealing of the foundation seal is maintained.

I. Where foundation piles are not used on piers, abutments, retaining walls, and wing walls and excavation to suitable bearing must be made below the as planned bottom of the foundation, the additional excavated spaces under these substructure units shall be backfilled with subfoundation concrete or the footing elevation shall be lowered, or the footing deepened as specified in the Contract Documents or as directed by the Engineer. Rock foundations that are to receive footing concrete shall have a rough finish. Where excavation to suitable bearing for box culverts must be made below the as planned bottom of the foundation, additional excavated spaces under the barrels shall be backfilled with selected backfill.

3.5 COFFERDAMS AND FOUNDATION SEALS

A. When cofferdams are required, the Contractor shall submit for review, Drawings and a complete description of the process for Construction of the cofferdam. Timber or bracing left in the cofferdams or cribs shall not extend into the substructure concrete. Cofferdams shall be constructed to protect the concrete against damage.

1. Foundation Seal: When the foundation cannot be dewatered, the Engineer may require the Construction of a concrete foundation seal. The Contractor shall submit for review Drawings and description of the process before placing the seal. If a mud wave is created during the placement of the tremie seal, the displaced material shall be removed in order to preserve the full foundation cross section specified in the Contract Documents. The foundation shall then be pumped out and the footing placed in the dry. When weighted cribs are employed and the crib's weight is utilized to overcome a part of the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level as directed.
2. Pumping: Pumping is prohibited during the placing of concrete. Pumping to dewater a sealed cofferdam shall not begin until the seal has set sufficiently to withstand the hydrostatic pressure.
3. Removal of Cofferdams or Cribs: Cofferdams or cribs shall be removed by the Contractor after the completion of, and without damage to the substructure.
4. Stability of Foundation: The Contractor shall stabilize the foundation area so that the concrete footing can be constructed in the dry and in its proper place.

5. Protecting Existing Structures or Utilities: When foundations are located such that excavation may endanger or interfere with an existing structure or utility, the location of bracing and method of protection shall be subject to approval by the owner of the structure or utility.
6. Inspection: After each excavation has been completed, the Contractor shall notify the Engineer and request its inspection and approval. Concrete shall not be placed until the depth of the excavation and the character of the foundation material has been approved.

3.6 BACKFILLING

All excavated spaces resulting from structure excavation not occupied by the portions of the permanent Work shall be backfilled with suitable material. The backfilling shall be carried to the surface of the surrounding ground or grade as specified in the Contract Documents. Borrow shall not be used until the available project excavation is exhausted. The top surface of the backfilled areas shall be neatly graded. Backfill compaction shall conform to 31 24 13.10, (Embankment and Subgrade) or 31 23 23.10, (Tamped Fill).

3.7 BACKFILLING AGAINST STRUCTURES

A. Backfilling against various structures shall be performed as follows:

1. Brick Masonry: Backfilling will not be permitted until seven (7) days after completion of the section.
2. Concrete Structures: Backfilling will not be permitted until curing is completed and the concrete has achieved eighty percent (80%) of the specified compressive strength.
3. Footings, Culverts and Piers: Fill placed around footings, culverts and piers shall be deposited on both sides to approximately the same elevation at the same time.
4. Abutments, Retaining Walls, Culverts or Other Structures: The bed for the backfill shall be built up in horizontal layers so that at all times there is a horizontal berm of uniformly compacted material behind the structure for a distance at least equal to the height of the abutment or wall remaining to be backfilled, except where undisturbed material protrudes into this area. Compaction of the berm shall conform to 31 24 13.10, Part 3, (Embankment and Subgrade). Jetting of fills or other hydraulic methods involving liquid or semi liquid pressure within the berm area is prohibited.

PART 4 MEASUREMENT AND PAYMENT

A. Class 3 excavations will be measured and paid for at the Contract Unit Price per cubic yard for the volume of material actually removed from within the limits specified.

B. No measurement or payment will be made for removing any water or liquids.

C. Class 3 excavations will extend a maximum of eighteen inches (18″) to vertical planes outside of the structure. Where blasting is required, a maximum of six inches (6″) will be allowed below the planned elevation.

D. Class 3 excavations will include excavation for bridges, box culverts, and other structures as specified in the Contract Documents.

E. The upper limits for Class 3 excavation on existing ground or embankments will be the existing ground line or the lower limit of roadway excavation. The lower limit of the two will control.

F. The upper limits for Class 3 excavation on preliminary embankments will be the bottom of the as planned footing elevation. For stepped footings the upper limits will be the bottom of the as planned footing elevation of the highest portion of the footing. When the preliminary embankment has a surcharge, the upper limits will be the lower limit of roadway excavation.

G. The payment for Class 3 excavation specified in the Contract Documents will be full compensation for all excavation, backfill, filling void around footings due to removing forms, blasting, grout, dewatering, removal and disposal of excess or unsuitable material, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. When an item for Class 3 excavation is not included in the Contract Documents, the excavation will not be measured but the cost will be incidental to other items.

H. Excavation for pipe culverts, culvert end walls, inlets, and manholes is excluded from the Class 3 excavation.

I. Additional excavation required below the elevation specified in the Contract Documents and necessitated by the lowering or deepening of footings, or the placing of subfoundations or underpinning, will be measured and paid for at the Contract Unit Price for Class 3 excavation.

J. Sheeting, bracing, and shoring either removed or left in place, will not be measured but the cost will be incidental to other pertinent items unless otherwise specified in the Contract Documents.

K. Excavation necessary to expose or remove piles, grillages, sheeting, cribbing, masonry, or other obstructions will not be measured nor paid for if the excavation occurs outside the limits of excavation. The removal and disposal of obstructions within the limits of excavation will not be measured separately but the cost will be included in the Contract Unit Price for Class 3 excavation.

31 23 16.17 EXCAVATION FOR INCIDENTAL CONSTRUCTION (CLASS 3)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of excavation below the planned elevation as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

The area to be excavated shall be the size, depth and location as authorized by the Engineer. Backfill shall conform to 31 23 23.13, (Selected Backfill). Refer to 31 23 16.16, Part 3.2, (Structure Excavation) for excavated material.

PART 4 MEASUREMENT AND PAYMENT

A. Class 3 Excavation for Incidental Construction will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Backfill. Backfill will be measured and paid for as specified in 31 23 23.13, Part 4, (Selected Backfill).

31 23 23.10 TAMPED FILL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of compacting embankment and backfill materials by means of mechanical tampers or vibratory compactors. This method of compaction shall be used wherever materials cannot be adequately compacted by other methods approved by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Refer to 31 23 16.12, Part 2.

PART 3 EXECUTION

A. After approval has been given by the Engineer, the areas shall be backfilled with materials approved by the Engineer. The material shall be placed in horizontal layers not to exceed six inches (6″) loose depth over the entire area to be tamped and uniformly compacted by means of mechanical tampers or vibratory compactors. The moisture and compaction requirements shall conform to 31 24 13.10, Part 3.4, (Embankment and Subgrade).

B. When backfilling around abutments, retaining walls, culverts, utilities, or other structures, special care shall be taken to prevent any wedging action against the structure by the material being compacted. The existing slopes to be filled against shall be benched or stepped. The backfill shall be constructed in horizontal layers as described above and wide enough that there shall be a horizontal berm of thoroughly compacted material behind the structure at all times for a distance at least equal to the height of the structure remaining to be backfilled, except insofar as undisturbed material protrudes into this space. Tamping may be required over additional widths when the material cannot be adequately compacted by other methods. When structures are installed below subgrade

in embankments, the tamped fill shall be placed to a depth of one foot (1′) over the top of the structure, while in excavation sections the tamped fill shall extend to the surface of the finished earthwork.

PART 4 MEASUREMENT AND PAYMENT

Compacting embankments and backfills by mechanical tampers or vibratory compactors will not be measured but the cost will be incidental to the pertinent items specified in the Contract Documents.

31 23 23.13 SELECTED BACKFILL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of placing selected backfill material as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. No. 57 Aggregate shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Crusher Run Aggregate CR-6 shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

PART 3 EXECUTION

Unsuitable foundation material shall be replaced as directed by the Engineer. Refer to 31 23 23.10, (Tamped Fill) for compaction.

PART 4 MEASUREMENT AND PAYMENT

Selected Backfill using No. 57 Aggregate or Selected Backfill using Crusher Run Aggregate CR-6 will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for compaction and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

31 23 23.24 HYDRAULIC FILL

PART 1 GENERAL

1.1 DESCRIPTION

This item comprises the furnishing, transportation and placing or fill or embankment material, obtained by hydraulic dredging, transported by pumping and placed by ponding or allowing the solids to settle out of the effluent discharging from the dredging pipe lines.

PART 2 PRODUCTS

2.1 MATERIALS

Dredging material for the body of the hydraulic fill shall be as noted in the Special Provisions or shall be A-3 soil with a maximum dry density of at least one hundred five (105) lbs. per cu. ft. as determined by American Association of State Highway and Transportation Officials (AASHTO) T 180, Method C unless the material has more than thirty-five percent (35%) retained on the No. 4 sieve, in which case Method D shall be used. Material one foot (1′) below the top of subgrade and above the water line shall be compacted to not less than ninety-two percent (92%) of the maximum dry density as specified in T 180. Material in the top one foot (1′) and above the water line shall be compacted to not less than ninety-seven percent (97%) of the maximum dry density. When necessary, the layer shall be wetted or dried in order to compact the layer to the required density. The resultant moisture content of embankment material, when finally compacted to required density, shall be within two (2) percentage points of optimum. In-place densities shall be determined by the Maryland Standard Methods of Tests (MSMT) 350 or 352.

PART 3 EXECUTION

A. The Contractor shall obtain all necessary permits from agencies of the U.S. Government, the State of Maryland, or other local authorities having jurisdiction before proceeding with any dredging operations. The Contractor shall also obtain all necessary releases and permissions in writing before the fill is made from all property owners along the right of way where the fill is to be made and shall assume full responsibility for any spillage on or damage to said property.

B. The Contractor shall protect adjacent properties and water channels against damage from the spread of hydraulic fill material or runoff from the filling operations unless it obtains permission from the property owners to discharge such material on their lands. Prior to final acceptance of the Work and as a condition thereto, the Contractor shall secure and deliver to the Engineer written releases from the property owners and other affected parties protecting the City against claims of any such spread or run-off onto adjacent property.

C. Embankment constructed with hydraulic fill must be completely made by this method except for the cover of blanket material, which may be supplied from other sources. Hauled borrow or other suitable material from excavating material may not be used in the same area as the body of the hydraulic fill without special permission from the Engineer.

D. Excavation of unsuitable material shall be completed in any area before the hydraulic fill is placed. The proposed bottom for the embankment shall be determined by the Engineer by test after the excavation is completed and no fill material shall be placed until necessary measurements of the excavated area have been made. In areas from which unsuitable material has been removed, hydraulic fill shall be deposited in the form of a wedge with its apex progressing along the centerline of the embankment and its sides flared back so as to make an angle of approximately thirty degrees (30°) with the centerline of the embankment. The manner of filling and advancing the wedge shall be such as to force any remaining liquefied silt and muck laterally to the sides of the excavation and not entrap it under the fill. Any mud wave thereby created shall be removed by mechanical means if and as directed by the Engineer and any muck or silt spilled on the top or sides of the embankment shall also be removed.

E. The points on the embankment at which the material is discharged shall be located and regulated so that material which will pass a two hundred (200) mesh screen or finer will not accumulate within the embankment. If pockets of more than two (2) cu./yds occur they shall be excavated at the Contractor's expense, removed and wasted and the pockets refilled with approved material.

F. If hydraulic filling proceeds during freezing weather, any frozen material or ice, which may form on the embankment, shall be removed before the next layer is placed.

G. All dikes constructed along the slopes to retain the fill shall be trimmed to the proper preliminary cross section, before placing cover material. The Contractor shall provide the necessary temporary bulkheads, weir boards and retaining structures so as to confine the discharge material within the embankment limits. The embankment shall be shaped to line and grade before the specified depth of blanket material is placed and the final cross section of the embankment shall be as indicated on the Plans.

H. Above the elevation of the existing ground line the fill shall be placed in layers, not to exceed one foot (1′) in thickness, over the full width of the embankment.

I. The flow of the natural surface drainage shall be maintained at all times within the existing ditches and channels or in new ones provided by the Contractor for that purpose. Upon completion of the hydraulic fill operation, existing streams and new channels shall be restored to their former or prescribed cross sections wherever fill material or sediment from run off has washed, spread or been otherwise deposited therein, and has thereby reduced the former or prescribed cross section by measurable amount. No payment will be made for the removal of such material.

PART 4 MEASUREMENT AND PAYMENT

A. Unless otherwise noted, Hydraulic Fill will be measured in place in the embankment, whether above or below the original ground line or water line on the basis of the volume in place within the prescribed pay limits as shown on the Plans or described in the special provisions. Measurements will be made by cross sections and volumes and will be computed by average end areas, from the cross sections of the original ground combined with the cross sections of the completed Work. No allowance will be made for over-fill, for wasted material, for material lost as a result of methods used or for additional material placed as a result of subsidence, compression, displacement or slides.

B. Payment for hydraulic fill will be made on the basis of the Contract Unit Price per cubic yard for Hydraulic Fill, complete and in place. This shall constitute full compensation for furnishing all labor, dredging, pipeline, materials and incidentals necessary for the satisfactory completion of this item as specified herein. No additional compensation will be allowed for the baffles, bulkheads, weirs, dikes, etc., for displacement or slides, for cleaning out waterways or for shaping the embankment surface or slopes to the required cross sections.

31 23 23.33 FLOWABLE FILL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, hauling and placing a flowable cement stabilized backfill material as specified in the Contract Documents or as directed by the Engineer. The material shall be used for utility cut backfill and shall set up to a stabilized mass.

PART 2 PRODUCTS

1.2 MATERIALS

A. The flowable backfill shall consist of a mixture of fly ash, cement, and water and shall be certified by the manufacturer.

B. Cement. Cement shall conform to 03 30 00, (Portland Cement Concrete Structures)

C. Fly Ash. Fly ash shall conform to 03 30 00, (Portland Cement Concrete Structures)

D. Water. Water shall conform to 03 30 00, (Portland Cement Concrete Structures)

E. Fillers. Fillers, when required shall be natural aggregates with a maximum size of three-quarters inch (3/4″) and may include sands. Bottom ash shall not be used as a filler.

F. Components. Toxic or deleterious components shall not be used in the backfill mixture. The mixture shall have a twenty-eight (28) day, unconfined compressive strength of one hundred (100) psi minimum based on the manufacturer's certification. Certification shall include the actual test data for each mixture to be used.

G. Analysis. Chemical analysis of the fly ash used in the mixture conducted by the Contractor shall conform to federal toxicity standards. An analysis shall be conducted on fly ash from each stockpile whenever the coal source is changed, replenished or when fly ash from a different source is used. The results of the analysis shall be submitted to the Engineer for approval prior to using the mixture.

PART 3 EXECUTION

A. Placement of the flowable backfill material shall conform to the manufacturer's recommendations or as directed by the Engineer. Utility trenches shall be backfilled full depth to the top of the subgrade using the mixture as specified in the Contract Documents or as directed by the Engineer.

B. The mixture shall fill all voids during the backfill operation.

C. The backfilled utility cut shall be protected from freezing and traffic for twenty-four (24) hours. Paving operations shall not begin for at least twenty-four (24) hours after backfilling is completed and has been approved by the Engineer.

D. The Contractor shall keep detailed records of all flowable backfill placed. Records shall include the source of the fly ash, date placed, the location, depth, and the quantity used. These records shall be submitted to the Engineer.

PART 2 MEASUREMENT AND PAYMENT

Flowable backfill for utility cuts will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

31 23 23.53 POROUS BACKFILL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and placing of porous backfill material, reinforced concrete base and pipe drains at the rear of abutments, wing walls, retaining walls, and other locations as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Porous Backfill, Size No. 57, Aggregate shall conform to the following Table A.

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

MATERIAL		SIEVE SIZE				
		1-1/2"	1"	1/2"	No. 4	No. 8
COARSE AGGREGATE - PORTLAND CEMENT CONCRETE	57 and UNDERDRAIN (h)	100	95–100	25–60	0–10	0–5

B. Concrete Mix No. 1 shall conform to the following Table B.

TABLE B – CONCRETE MIXTURE NO. 1

28 DAY SPECIFIED COMPRESSIVE STRENGTH psi	STANDARD DEVIATION psi	CRITICAL VALUE psi	MIN CEMENT FACTOR lb/yd^3	COARSE AGGREGATE SIZE M 43	MAX WATER/ CEMENT RATIO by wt	SLUMP RANGE inches	TOTAL AIR CONTENT %	CONCRETE TEMP. °F
2500	375	2430	455	57, 67	0.55	2 – 5	5 – 8	70 ± 20

C. Pipe Drains:

1. The pipe drains shall conform to the following Table C.
2. The manufacturer shall furnish certification for all pipes, which verifies that, the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall

be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

TABLE C – PIPE DRAINS		
MATERIAL	**SPECIFICATION**	**REMARKS**
Nonreinforced Concrete Pipe	M 86, Class 3	—
Reinforced Concrete Pipe	M 170, Class 4 & 5	54 inches and smaller diameter M 170, load bearing option. 60 inches and larger diameter M 170, material option.
Concrete End Sections	M 170	—
Polyethylene (PE) Plastic Drain Tube or Pipe	M 252 or M 294	—
	M 252	underdrain outlet pipes Type S minimum pipe stiffness 50 psi.
Polyvinyl Chloride (PVC) Plastic Pipe & Drain Pipe	AASHTO Bridge Section 18PVC Ribbed Pipe	—
	M 278	underdrain outlet pipes.
	F 758, Type PS 28, D 3034, SDR 35 (a), M 278 (a)	perforated underdrain.
Reinforced Concrete Arch Culvert	M 206	—
Reinforced Concrete Elliptical Pipe	M 207	horizontal elliptical pipe only.
Preformed Rubber Joint for Circular Pipe	M 198, Type A	—
Corrugated Steel Pipe, Pipe Arches & Underdrain	M 36 (b)	end finish shall be annular corrugations
Corrugated Aluminum Alloy Pipe	M 196 (b)	end finish shall be annular corrugations
Structural Plate for Pipe, Pipe Arches & Arches	M 167	—
Copper Pipe	Federal Spec WW – T – 799 Type K	—
Polyethylene (PE) Precoated Corrugated Steel Pipe	M 245 & M 246	minimum thickness 10 mil on each of the surfaces.
Concrete Drain Tile	M 178	—

Note: (a) Perforations shall conform to the requirements of F 758.
Note: (b) Bands with dimples are prohibited.

3. The producer shall maintain a City approved quality control form for all pipes produced for use on City projects. Each form, for each lot shall contain the data as mentioned in the following Table D.

TABLE D			
PIPE DIMENSIONS	**REINFORCEMENT**	**TESTS**	**GENERAL INFORMATION**
Diameter Length Wall Thickness Joint Style	Size Spacing Area-Spec & Test Results Adequacy & Quality of Welds & Splices	Cylinder Compressive Strength Spec & Test Results Core Compressive Strength Spec & Test Results Absorption Spec & Test Results Visual Inspection	Plant Name Technician Signature Lot Identification Production Dates Pipe Class Units Per Lot Material Sources Cement Fine Aggregate Coarse Aggregate Reinforcement
THREE EDGE BEARING			
0.01 inch Crack Strength Spec & Test Results	Ultimate Strength Spec & Test Results		

D. Reinforcement Steel: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices, shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to the following:

1. The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss.
2. Epoxy coatings shall conform to D 3963.
3. Material used for the touch-up system shall be a two (2) part epoxy system designated and color matched for patching the epoxy coating used. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured one (1) hour after application at thirty-five degrees (35°) F ambient.

4. The manufacturer shall furnish certification of epoxy protective coatings, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

E. Geotextile: Class as specified and all geotextiles shall be listed in the National Transportation Product Evaluation Program (NTPEP) for geotextiles. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum ninety-five percent (95%) by weight of polyolefins or polyesters. The fibers shall be formed into a stable network so that the filaments or yarns retain their dimensional stability relative to each other, including selvages. The geotextile shall conform to the following Table E.

TABLE E						
MARYLAND APPLICATION CLASS	**TYPE OF GEOTEXTILE**	**GRAB STRENGTH lb D 4632**	**PUNCTURE STRENGTH lb D 4833**	**PERMITTIVITY sec[1] D 4491**	**APPARENT OPENING SIZE, max Mm D 4751**	**TRAPEZOID TEAR STRENGTH Lb D 4533**
SD TYPE I	NONWOVEN	160	56	0.50	0.43	55
	WOVEN, MONOFILAMENT	250	90	0.50	0.43	90
TYPE II	NONWOVEN	160	56	0.20	0.25	55
	WOVEN, MONOFILAMENT	250	90	0.20	0.25	90
PE TYPE I	NONWOVEN	200	80	0.70	0.43	80
	WOVEN, MONOFILAMENT	250	90	0.70	0.43	90
TYPE II	NONWOVEN	200	80	0.20	0.25	80
	WOVEN, MONOFILAMENT	250	90	0.20	0.25	90
TYPE III	NONWOVEN	200	80	0.10	0.22	80
	WOVEN, MONOFILAMENT	250	90	0.10	0.22	90
SE	NONWOVEN	200	80	0.20	0.30	80
	WOVEN	250	90	0.20	0.30	90
ST	WOVEN	300*	110	0.05	0.15**	110
F	WOVEN	100	–	0.05	0.60	–
E	NONWOVEN	90	30	0.50	0.30	30

Note 1. All property values are based on minimum average roll values in the weakest principle

Note 2: The ultraviolet stability shall be 50 percent after 500 hours of exposure for all classes, except Class F, which shall be 70 percent (D 4355).

* Minimum 15 percent elongation.

** This is a MINIMUM apparent opening size, not a maximum.

1. Only those geotextiles that have been tested by NTPEP will be considered candidates for use. In addition, the geotextiles shall conform to the Contract Documents and to the geotextile acceptance and quality assurance procedure, Maryland Standard Methods of Tests (MSMT) 732.

2. Geotextiles used for reinforcement applications shall have a separate approval process.

   a. When geotextiles are joined by sewing, the geotextile seam shall conform to the following:

      1) Seams shall be either "J" or "Butterfly" type and shall utilize a lock stitch.
      2) Seams shall conform to the tensile strength requirements for the geotextile when tested across the seam.
      3). The durability of the thread for seaming shall be at least equal to the geotextile itself.

3. Securing pins or staples shall have a minimum ten inches (10″) length and shall be designed to securely hold the geosynthetic in place during Construction.

PART 3 EXECUTION

A. Porous backfill material shall be placed in layers in conjunction with the adjacent fill. Any fill material removed for placing the porous backfill material shall be at no additional cost to the City. When a form is used between the porous backfill material and the earth backfill, the form shall be completely removed from the completed fill.

B. Concrete base shall be sloped to drain to points of discharge.

PART 4 MEASUREMENT AND PAYMENT

A. Porous backfill will not be measured but will be paid for at the Contract lump sum price for the pertinent porous backfill item. The payment will be full compensation for all excavation, concrete, reinforcement, geotextiles, drains, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. If no item for porous backfill appears in the Contract Documents, the Work will not be measured but the cost will be incidental to other items specified in the Contract Documents.

31 23 33 TRENCHING AND BACKFILLING, POINT EXCAVATION AND BACKFILL

PART 1 GENERAL

1.1 DESCRIPTION

Trench/Point excavation, backfill, and compaction shall include, but not necessarily be limited to, the excavation, backfill, and compaction of trenches for storm drains, water mains, valves, fire hydrants, sanitary sewers, and other underground utility systems shown on the Plans, and in accordance with the Contract Documents.

1.2 QUALITY ASSURANCE

A. Field Requirements

1. During the Contract's Construction period the Contractor shall ensure that filled areas will not suffer from ponding or settlement in excess of the following limitations:

   a. Paved areas and areas within five feet (5′) of structures, five hundredths (0.05) foot.
   b. Unimproved areas, five tenths (0.50′) foot, sloped to provide positive drainage.
   c. All other areas in public right of way, one tenth (0.10') foot.

2. Fill material, which settles in excess of the above limitations, shall be removed and replaced with suitable material at no cost to the City. Structures, paving, landscaping and other site improvements damaged by settlement, shall be removed and replaced at no cost to the City.

B. Inspection and Testing:

Placing fill material and performing earthwork will be subject to continuous inspection. The Engineer may make field density tests of the compaction of each layer of fill in accordance with 31 23 23, (Tamped Fill) and 01 45 25, (Test of Materials). Allow time for the Engineer to perform the tests after completion of each layer of fill in a designated area. The Contractor shall provide equipment to cut out smooth surfaced spot locations designated by the Engineer on which to perform the test.

1.3 SUBMITTALS

A. Rock Excavation

1. Rock excavation employing methods other than the use of explosives shall be submitted to the Engineer for approval. A detailed description of the means, methods, equipment and materials used, and methods for limiting ground motion and airblast shall be submitted to the Engineer. Regardless of the methods for rock excavation, the Contractor shall conform to the requirements for the use of explosives or blasting, as described herein.
2. Prior to drilling and blasting, the Contractor shall meet the requirements of all submittals. Submittals to the Engineer of the Blasting Schedule, of the Blasting Plans, of all blasting operations, and of blasting products, and compliance by the Contractor with provisions for protection of life and property shall not relieve the Contractor of the sole responsibility or liability for the safety of all persons and property. Also see 01 45 34, (Use of Explosives).
3. The Contractor's submittals to the Engineer shall not constitute nor shall they be construed to be a guarantee by the Engineer that the desired results will be achieved. Submittals to the Engineer shall not relieve the Contractor from the responsibility of complying with the requirements of these Specifications.
4. Unless otherwise stated in the Contract Documents, where rock removal is necessary, the Contractor shall engage the services of a vibration consultant, who shall be approved by the Engineer, to advise on explosive charge weights per delay and to analyze results from seismographic recordings. The Contractor shall employ only personnel qualified by training and experience to perform vertical wall trenching by blasting in high damage potential areas, close to, above and below ground structures, including pipelines and utilities. All individual blasts shall be kept to a practical minimum as determined by seismograph recordings analyzed by the vibration consultant. The Contractor shall maintain close supervision of the blasting

personnel and ensure that all Federal, State and local blasting regulations, explosive manufacturer's instructions and requirements of the vibration consultant are complied with. Refer to COMAR 08.05.21, 'Surface Mining' published in Maryland Register Vol. 14, issue of July 17, 1987, for details of the qualifications of personnel, handling the explosives, blasting procedures and limitations on the effects of blasting, except as modified herein.

5. Blasting Plan: In each distinct individual blasting area where pertinent factors affecting blasting vibrations and their effects in the area remain the same, the Contractor shall submit a blasting plan of the initial blasts to the Engineer for approval. The plan must consist of hole size, depth, spacing, burden, type of explosive, type of delays, delay sequence, maximum amount of explosive on any one (1) delay period, depth of rock, and depth of overburden if any, as well as the blast location relative to all utilities within three hundred feet (300′).
6. Blasting Contractor Documentation: Blasting Contractor Documentation shall be submitted to the Engineer for approval documenting that the Blasting Contractor has at least five (5) years of experience and evidence of the satisfactory completion of at least five (5) blasting programs or operations comparable in scope to this Work. The Blasting Contractor shall submit documentation of licensing required by County, State, Federal or other regulatory authorities having jurisdiction. The blasting Contractor shall apply for and obtain all required blasting permits, and shall submit documentation to the Engineer.
7. Blasting Schedule: The blasting Contractor shall develop a blasting schedule detailing the date, time and location of proposed blasts. The blasting Contractor shall also provide a blasting Schedule to any public utilities, private residence, or others possibly affected. Blasting operations shall be restricted to between the hours of 8:00 AM. and 5:00 PM., Monday through Friday unless otherwise stated in Contract Documents. Any variation to this restriction must be approved in writing by the Engineer.
8. In the event that blasting is to occur within three hundred feet (300′) of any BGE/Verizon facility, the Contractor must include in its blasting plan, an outline showing how it will prevent damage to said utilities during blasting operations, and specifically how the Contractor will comply with the BGE Blasting Guidelines, (BGE Specifications C-G-709). These Specifications can be obtained by contacting BGE Damage Prevention at 410 291-5682.

B. Delivery Tickets: When requested by the Engineer, submit delivery tickets with each load of backfill and bedding material showing the following information:

1. Name and location of supplier.
2. Type and amount of material delivered.

PART 2 PRODUCTS

2.1 MATERIALS.

A. Detailed Material Requirements

1. Use and Ownership of Excavated Material

a. All suitable material excavated from utility trenches shall be used, as far as practicable, for backfill in trenches. Fill material for trench backfill shall meet the common borrow requirements set forth in 31 24 13.10, (Embankment

and Subgrade) and 31 23 16.12, (Borrow Excavation). Trench backfill up to three feet (3′) over the top of the pipe shall contain no rock or gravel larger than three inches (3″). From three feet (3′) over the top of the pipe up to the top twelve inches (12″) below the proposed pavement base course or finished grade no rocks larger than six inches (6″) in their greatest dimension will be permitted and no rocks or gravel larger than three inches (3″) will be permitted in the top twelve inches (12″). When located in paved roadbeds, subject to either public or Construction traffic the backfill below the pavement base course shall be as per the Standard Details and 32 01 30.10, (Patch Existing Pavement and Reset Utility Services)

b. When specifically noted in the Contract documents, the Contractor shall properly store, stockpile and protect all materials that are to be reused in the Work. The Contractor shall replace, at the Contractors own expense, material that was suitable when excavated, which has subsequently become unsuitable because of careless, neglectful, wasteful, or unprotected storage. All unsuitable and surplus suitable material, as determined by the Engineer, shall be removed from the excavation and disposed of off-site by and at the expense of the Contractor

2. Borrow

a. Borrow material for trench backfill shall meet the requirements of 31 23 23.10, (Tamped Fill), for common borrow. AASHTO M43 size No. 6, may also be used as backfill material. Prior notification of at least twenty-four (24) hours shall be given by the Contractor as to the source and quantity of borrow material to be used. Acceptance of the material from any location shall not be construed as approval of entire location but only insofar as the material continues to meet the Specification requirements.

1. Selected Backfill for pipe foundation and bedding shall meet the requirements of 31 23 23.13, (Select Backfill).
2. Pavement Repairs shall be in conformance to 32 01 30.10, (Patch Existing Pavement and Reset Utility Services)
3. Bedding for Pipe and Pipe Structures

a. Bedding for ductile iron shall meet requirements of fill material for trench backfill unless specified otherwise in the Contract Documents.

b. Bedding for all other pipe shall be granular bedding in conformance with the standard details and 32 11 23.10, Part 2 (Aggregate Base Course) unless otherwise specified in the Contract Documents.

4. Gravel backfill below subgrade: Replacement for unsuitable material shall meet requirements of 31 23 23.13, (Select Backfill).
5. Sheeting, shoring and bracing materials shall be timber, steel or aluminum, or a combination thereof, designed as required, to retain the earth around structures, prevent cave-in and settlements, and to fulfill all safety requirements.

a. Timber shall be structural grade with minimum working stress of eleven hundred (1,100) psi.

b. Steel sheet piling shall conform to requirements of ASTM A328, continuous interlocking type. Struts, bracing and all other accessories required for the sheet piling system shall meet requirements of ASTM A36.

c. Trench Erosion Check: Wood for trench erosion checks shall be pine treated with chromated copper arsenate in accordance with AWPA C2.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Clearing and Grubbing

1. The Contractor shall clear and grub the surface over the line of the trench in accordance with the requirements of 31 11 00, (Clearing and Grubbing).
2. To protect against accidental clogging, sanitary sewer channels in existing manholes shall be covered, as directed by the Engineer, prior to any grubbing or grading operations.

B. Removing Pavement, Sidewalk, Curb, etc.

1. The Contractor shall remove pavement, sidewalk, curb, etc. over the line of the trench in accordance with the requirements of 32 01 30.10, (Patch Existing Pavement and Reset Utility Services).
2. The Contractor shall remove paving only to the width shown on the Standard Details, noted in the Special Provisions, or as directed by the Engineer. When the Contractor removes paving for a greater width than is deemed necessary or disturbs paving, sidewalk, curbs, etc. due to settlement, slides, or cave-ins, or in making excavation outside the limits of the trench without written order of the Engineer, the City will require the Contractor to replace the excess damaged area. The Contractor shall be responsible for repaving or surfacing roadbeds or sidewalk, curbs, etc. that have failed, settled, or have been damaged at any time before expiration of the Contract maintenance period due to Work or any other activities by the Contractor, the Contractor's Subcontractors, or suppliers.

C. Removing Street Signs, Fences, Shrubs, Trees, and Other Improvements

1. The Contractor shall remove improvements from the working strip in accordance with the requirements of 31 11 00, (Clearing and Grubbing).
2. In addition to the requirements contained 01 76 01, (Preservation and Restoration of Property, Trees, Monuments, Streams, Lakes, and Reservoirs), the following shall apply:

a. Unless otherwise indicated in the Contract Documents, existing fences shall be carefully removed to the extent required to permit Construction operations and as directed by the Engineer. The Contractor shall safely store all elements during the time that they are down.

b. Unless otherwise indicated in the Contract Documents, shrubs, hedges, and trees shall be transplanted with sufficient earth to insure that no damage to the root system occurs. General reference is made to 32 90

00.01, (Planting Trees, Shrubs, Vines and Seedling Stock) for acceptable planting methods. After transplanting has been accomplished, it shall be the Contractor's responsibility to water all plants. The transplanting of trees will only be required when indicated on the Plans.

D. Maintaining Traffic

The Contractor shall furnish all labor, tools, equipment, and materials specified in 34 01 13, (Operation and Maintenance of Roadways) for the maintenance of traffic during Construction.

3.2. TRENCH EXCAVATION

A. General

1. Excavation for the installation of utilities shall be unclassified and shall consist of the excavation of all material encountered to the lines, grades, and sections shown on the Plans and/or the Standard Details, as specified, or as directed by the Engineer.
2. Trenches may be excavated and backfilled either by hand or by machinery as the Contractor may elect. The Contractor shall have no claims, nor will extra compensation be allowed, for hand excavation or backfill, which may be required by these Specifications or by the Engineer for protection of existing utilities or structures.
3. Ground profiles shown on the Plans represent the elevations along the centerline of the trench.

B. Protection of Property and Structures

The Contractor shall, at the Contractors own expense, sustain in place and protect from direct or indirect injury all existing facilities in the vicinity of the excavation, whether above or below the ground, or that may appear in the trench. The Contractor shall be responsible for the implementation of protective measures associated with the presence or proximity of pipes, poles, tracks, walls, buildings, property markers, and other structures and property of every kind and description in or over the Contractor's trenches or in the vicinity of the Contractor's Work whether above or below the surface of the ground. The Contractor shall be responsible for all damage and assume all expense for direct or indirect injury caused by the Contractor's Work, to above ground facilities or below ground facilities shown on the Plans.

C. Utility Adjustments

1. All adjustments to utilities other than those owned by the City shall be performed by the utility owner.
2. It shall be the responsibility of the Contractor to perform all adjustments to existing water/sewer utilities at its expense. Adjustments to water services between the property line and the water main shall be performed by qualified Utility Contractors. Adjustments between the property line and the house shall be performed under the supervision of a registered master plumber.
3. Adjustments to sanitary sewers within the City right-of-way shall be accomplished by a qualified Utility Contractor. Sanitary house connection adjustments inside the

City right of way and adjustments to sanitary sewers outside the City right-of-way may be performed under the supervision of a registered master plumber.

4. It shall be the Contractor's responsibility to obtain all permits necessary for the performance of this Work, along with obtaining all City approvals.

D. Obstructions Shown on Plans

1. Certain information regarding the reputed presence, size, character, and location of existing underground utilities and structures has been shown on the Plans based upon available records. There is no certainty of the accuracy of this information, and it shall be considered by the Contractor in this light. If test pit data is not shown on the Plans, the Contractor shall excavate test pits in advance of the Contractors Work in accordance with 31 23 16.05, (Test Pit Excavation) locate existing utilities.
2. It shall be the responsibility of the Contractor to notify "Miss Utility," all municipal utilities, all pipeline owners, and any other parties affected prior to the beginning of Work.

E. Removing Obstruction

1. The Contractor may break through any utility that in the judgment of the Engineer is no longer in use. The applicable utility abandonment procedures shall be followed.
2. In the event that obstructions would delay the Work of pipe installation, the Contractor, with the written permission of the Engineer, will be permitted to leave a gap in the Work and return to fill the gap after the obstructions have been removed. The installation shall be completed by laying full pipe lengths and appropriate closure pieces.
3. The Contractor shall coordinate with any persons, firms, or corporations or with the City in protecting, removing, changing, or replacing pipes, conduits, poles, or other structures.
4. In the event that the City has entered into any agreement with an affected utility owner or owners which will have an effect on operations or financial responsibilities of the Contractor, the requirements of these agreements will be included in the Special Provisions of the Contract.

F. Width and Depth Trenches

1. Trenches shall be excavated to the necessary width and depth as may be shown on the Plans or Standard Details, as specified in the Special Provisions, or as directed. The trench subgrade shall be such as to provide a uniform and continuous bearing and support for the pipe on solid undisturbed earth for the full length of each pipe, except for that portion at the bell hole. Any part of the bottom of the trench excavated below subgrade shall be backfilled with approved material, thoroughly compacted.
2. Subgrade, in the case of pipe lines, shall be the underside of the barrel of the pipe, where the pipe is laid on a natural foundation, or the bottom of granular bedding or concrete foundation, where indicated on the Plans or Standard Details, and the underside of ribs or sills where the pipe is installed on a timber foundation. For appurtenant concrete or masonry structures, subgrade shall be termed the

underside of the masonry, or gravel base, or fill material as shown on the Plans or Standard Details.

3. Trench sides shall be vertical to a distance of at least one foot (1′) above the top of the pipe. Above this point, the remainder of the trench shall be practically plumb when located in paved roadway rights-of-way. In easement areas, the side of the trench from one foot (1′) above the top of the pipe to the existing ground surface may be sloped or cut-back, subject to the approval of the Engineer.
4. Bell holes shall be excavated in the bottom of the trench whenever necessary to permit the proper making of joints.
5. When a pipe, structural plate pipe, or pipe arch is to be installed on existing ground on or under fill, the embankment shall be constructed to a height of at least nine inches (9″) above but not more then three feet (3′) above the top of pipe and then a trench excavated to receive the pipe.
6. Excavations for concrete encased electric duct banks shall be sufficiently wide to allow placement of ducts and spacers and to allow placement of forms for the concrete casement on the sides of the duct banks, if required by site conditions.
7. Use of trench boxes will be permitted in areas where excavation sidewalls are suitable and where sheeting, shoring and bracing is not required to maintain the excavation dimensions. The box shall be designed structurally to withstand pressures which may be imposed thereon. Trench boxes and their use shall meet requirements of MOSHA. No portion of the trench box shall extend below the top of the pipe during or after placement of the pipe bedding material. Steel plates may be used below the trench box in the pipe bedding limits and may be removed after pipe bedding is placed. Size of the box shall be as follows:

    a. Height shall be such as to assure safe working conditions.
    b. Length shall be sufficient to accommodate the size and lengths of pipe being installed.
    c. Width shall be so the trench opening will not be less than the minimum nor more than the maximum permitted in the Standard Details.

G. Length of Open Trench

1. The Contractor shall not excavate more trench in any day than can be completed (facility installed and trench backfilled) in the same day, unless by written permission of the Engineer. The Engineer shall be empowered at any time to require the backfilling of open trenches over completed pipe lines if, in the Engineer's judgment, such action is necessary; and the Contractor shall thereby have no claim for extra compensation, even though to accomplish said backfilling, the Contractor is compelled temporarily to stop excavation or other Work at any place.
2. If Work is stopped on any trench for any reason except by order of the Engineer, and the excavation is left open for forty eight (48) hours in advance of Construction, the Contractor shall, if so directed, backfill such trench at the Contractor's own cost and shall not again open said trench until the Contractor is ready to complete the structure therein. If the Contractor shall refuse or fail to backfill such trench completely within forty eight (48) hours after said notice, the Engineer is authorized to have the trench backfilled; and the City will charge the expense thereof to the Contractor and retain the same of any monies due or to become due to the Contractor under the Contract.
3. The excavation of all trenches shall be fully completed at least one (1) full pipe length in advance of pipe installation, unless otherwise authorized.

H. Responsibility for Condition of Excavation

The Contractor shall be responsible for the condition of all excavations made by the Contractor. All slides and caves, that are the result of negligence on the part of the Contractor, shall be removed without extra compensation.

I. Trench Support

1. All Work shall be performed in accordance with the latest OSHA/MOSHA requirements. The Contractor will submit its proposed trench support systems, sealed by a professional engineer, licensed in the State of Maryland, for review by the Engineer.
2. The Contractor shall support the sides and ends of all excavations wherever necessary with braces, sheeting, shoring or stringers, trench boxes, or other acceptable excavation support systems. All timbering shall be installed by men skilled in such Work and shall be so arranged that it may be withdrawn as backfilling proceeds, without injury to the utility or structure constructed or to any roadbed or adjacent structure or property.
3. All timbering in excavations, trench boxes, or excavation support systems shall be withdrawn as the backfilling is being done, except where and to such extent as the Engineer shall order in writing that said timbering or excavation support system be left in place or where the Engineer permits the trench support to be left in place at the Contractor's expense and upon the Contractor's request. The Contractor shall cut off any sheeting left in place two feet (2′) below finished grade and shall remove the material cut off without compensation therefore.
4. Wherever necessary, in running sand, or soft ground, or for the protection of any structure or property, sheeting shall be driven to such a depth below the bottom of the trench as may be required or directed.
5. The support of the trench shall be the sole responsibility of the Contractor.

J. Drainage and Dewatering

1. The Contractor shall grade the site as necessary to prevent surface water from flowing into the trench or other utility excavations and shall provide all necessary temporary surface drainage and keep the same operating to the satisfaction of the Engineer until permanent drainage or finished grading and permanent surface stabilization has been completed. Damming or ponding of water in gutters or storm drains will not be permitted.
2. It shall be the Contractor's responsibility to adequately control water that may be present in the excavation. The Contractor shall provide for the disposal of water removed from excavations in such a manner not to cause damage to public or private property or to any portion of the Work completed or in progress or cause any impediment to the use of any area by the public; nor shall the Contractor discharge any flushing or ground water or any material of any nature into existing sanitary sewer system during the Construction of the facilities. All water shall be discharged through an approved sediment control device. Water contaminated with raw sewage shall be directed into the existing sanitary sewer system. The costs of dewatering trench excavations will not be paid for directly, but will be included in prices Bid for other related items.

K. Tunneling and Jacking

Unless otherwise indicated, excavation shall be by open cut, except that short sections of a trench may be tunneled, or the pipeline jacked, if, in the opinion of the Engineer, the pipe, cable, or duct can be safely and properly installed.

3.3. FOUNDATION PREPARATION

A. General

The Contractor shall complete the excavation as far as practicable to the neat lines shown on the Standard Details or Plans or as directed by the Engineer. Planned sub-grade for pipe drains, sewer inlets and house connections without concrete encasement and/or concrete, stone or gravel cradle is the elevation of the underside of the barrel of the pipe. For pipe drains and/or sewers, miscellaneous structures and house connections encased in concrete or on concrete, stone and/or gravel cradle, the elevation of planned sub-grade is the lowest outside surface of the encasement or cradle specified. For masonry drains and sewers encased in concrete or on concrete, stone and/or gravel cradle, the elevation of planned sub-grade is the lowest outside surface of the encasement or cradle specified, in other cases, it is the lowest outside surface of the masonry drain or sewer.

B. Excavation Below Subgrade

1. The Contractor shall, without additional compensation, before any pipe or appurtenance is installed, fill all unauthorized depressions or irregularities in the bottom of the trench or tunnel with firmly compacted embankment or other approved material.
2. Where the bottom of the trench, at subgrade, is in unstable or unsuitable material, excavation shall be carried to such depth as recommended by the Engineer. The trench bottom shall be restored to subgrade with Selected Backfill. Refer to 31 23 23.13, (Selected Backfill).

3.4 CLASS 3 EXCAVATION FOR INCIDENTAL CONSTRUCTION

Class 3 Excavation for Incidental Construction shall include removal of unsuitable material when encountered at or below trench subgrade. It shall also include increases or decreases in the limits or amounts of excavation resulting from changes in pipe grade or location as previously described. Refer to 31 23 16.17, (Excavation for Incidental Construction Class 3) for additional requirements.

3.5 BACKFILL, COMPACTION, AND MAINTENANCE OF BACKFILLED TRENCH

A. Backfill

1. The Contractor shall backfill all trenches as rapidly as practicable after the installation of the utility therein, or after the excavation has served its purpose.
2. Place and compact granular bedding in accordance with the Standard Details. Place and compact granular bedding a minimum thickness of six inches (6″) under precast and cast-in-place structures. Backfill material around and over pipelines for a distance of two feet (2′) above the top of pipe shall consist of clean unfrozen earth, free of ash, refuse, large stones, or other material of an unsatisfactory character as

may be determined by the Engineer. Backfilling shall commence by depositing and then compacting by hand operated mechanical tampers suitable material in layers not more than six inches (6″) thick, measured loose, under, around, and over the pipe to a point not less than one foot (1′) in depth over the top thereof.

3. The remainder of the trench may be backfilled in layers in conformance with 31 23 23.10, (Tamped Fill). However, if the demonstration lift thickness is followed and the specified compaction is not obtained based on the Engineer's testing during backfilling, the Contractor shall, at the Contractor's own expense, remove, replace, and retest as many times as is required to obtain the specified compactions. In backfilling the remainder of the trench, stones of not more than six inches (6″) in largest dimension which have been taken out in excavating may be mixed with earth in an amount not exceeding twenty-five percent (25%) of the backfill volume. Stones of larger size or in greater quantities shall not be used, unless directed by the Engineer. The Contractor shall not permit excavations to be used for the disposal of refuse.
4. For sewer pipe fifteen inches (15″) and larger diameter and where a flexible connector is not used construct a grouted connection all around the pipe at each manhole.
5. Detectable warning tape furnished by the Contractor, shall be placed in the backfill directly over the centerline of water mainline, water and sewer house connections and pressure sewer piping for grinder pump systems. Tape shall be placed over sewer mainline when one or both manholes in a sewer reach are outside the limits of existing or proposed paved areas and when the sewer mainlines has less than six feet (6′) of cover. It shall be placed on compacted backfill not less than eighteen inches (18″) or more than thirty inches (30″) below the finished surface and with a minimal amount of splices. Overlap at splices and intersections of the tape shall be a minimum of six inches (6″). The tape will be six inches (6″) wide furnished in rolls of three hundred feet (300′) or portions thereof and in two (2) colors which shall be placed as follows: blue over water, and green over sanitary sewer. When water and sewer are installed in the same trench only blue detectable tape for water will be used.
6. When located in paved roadbeds, subject to either public or Construction traffic the backfill below the pavement base course shall be as per the Standard Details and 32 01 30.10, (Patch Existing Pavement and Reset Utility Services).
7. Backfill over arches and pipe arches shall be placed uniformly on both sides of the arch so as to load the arch uniformly and symmetrically. For structures without headwalls, backfill shall be commenced in the center of the structure. If the structure includes headwalls or spandrel walls, backfilling operation may commence at one wall and extend toward the opposite side, care being taken in all cases to bring embankment or sections thereof up evenly on each side to a height of not less than eighteen inches (18″) above top of structural plate pipe structures.
8. The Contractor, without extra compensation, shall take whatever special precautions are necessary in the placing and tamping of backfill around the sides of non-rigid pipe to insure that allowable deflections will not be exceeded.
9. Should additional material be required for backfilling in excess of that obtained from excavation, the Contractor shall obtain Borrow material from off-site sources, to complete the trench backfill.
10. Do not backfill around pipe, connections or fittings until measurements and locations are completed by the Engineer.
11. On steep slopes, place trench erosion checks at locations shown or as directed by the Engineer.

B. Compaction

1. The Contractor shall, in unimproved areas outside the public rights-of-way, compact each trench backfill layer in such a manner as to obtain a dense backfill free of voids and not susceptible to undue settlement or depression. Trench backfill extending to not less than one foot (1′) in depth above the top of pipe shall be compacted to at least ninety-two percent (92%) of maximum density at a moisture content within three percent (3%) of the optimum in accordance with AASHTO T 180.
2. Trench backfill within all public rights-of-way and improved or paved areas, shall be compacted to at least ninety-two percent (92%) of maximum density at a moisture content within two percent (2%) of the optimum moisture in accordance with AASHTO T 180. The final one foot (1′) of trench backfill to pavement subgrade shall be compacted to at least ninety-seven percent (97%) of maximum density at moisture content within two percent (2%) of the optimum in accordance with AASHTO T-180.
3. In-place soil density tests shall be performed horizontally every one hundred fifty (150) linear feet, or fraction thereof, and vertically every other eight inch (8″) lift with the compacted thickness not to exceed sixteen inches (16″).
4. Trench backfill for water and sewer laterals shall be tested for in place soil density with a minimum of one (1) density test per each lateral. Backfill around manholes, valves, or other structures shall be tested for in-place soil density with a minimum of one (1) test every three (3) vertical feet. The test locations for manholes shall be within three feet (3′) of the structure. For water and sewer valve clusters, the tests shall be conducted in the center of the cluster.
5. Utilize such compaction equipment as will not damage the pipe and pipe joints. Pipe and pipe joints damaged by the Contractor's operations shall be removed and replaced at no cost to the City

C. Maintenance of Backfilled Trench

1. The Contractor shall maintain, at the Contractor's own expense, all backfilled trenches in acceptable condition
2. If the Contractor fails to fill depressions in the backfilled trench within twenty-four (24) hours after the receipt of written notice from the Engineer, the Engineer may refill said depressions and the cost thereof shall be retained from any monies due the Contractor, under the Contract. In case of emergency, the Engineer may refill any dangerous depression or protect with lights wherever necessary without giving previous notice to the Contractor; and the cost of so doing shall be retained from any monies due or to become due the Contractor under the Contract.
3. The Contractor shall be responsible for any injury or damage that may result from lack of maintenance of any refilled excavation at any time prior to acceptance of the Project.
4. The Contractor shall furnish the Engineer with names, addresses, and telephone numbers of at least two (2) members of the Contractor's organization that may be contacted in an emergency.

3.6 BLASTING

A. The Contractor shall comply with 01 45 34, (Use of Explosives), 31 23 33, paragraph 1.3, (Trenching and Backfilling Point Excavation and Backfill) and the following requirements when excavating material using drilling and blasting or drilling and wedging techniques.

B. The Contractor is responsible for blasting in a safe manner, for producing smooth and sound rock surfaces at the lines of excavation; and for controlling damage and vibration.

C. Prior to Construction, the Contractor shall arrange a preconstruction meeting with the Engineer to discuss rock excavation procedures for this project.

D. Test Blasts: The initial blasts in any blasting shall be considered test blasts. The maximum amount of explosive charge weight shall be one (1) pound per delay period in these tests. Initial test blasts shall be monitored under the supervision of the vibration consultant at or above the existing pipelines or adjacent to the closest structure. The maximum explosive charge weight per delay period shall be determined from the initial test blasts, which will maintain the vibration effects at the adjacent pipelines or structures below the specified levels. The maximum charge weight per delay determined at this time shall not be increased without the advice of the vibration consultant or the approval of the Engineer. The sizes and time delays of the main shots will be determined by the test shots, with the peak particle velocity of any one (1) component not exceeding one point zero inches (1.0″) per second.

E. Prevention of Flyrock: All blasts shall be designed to prevent 'flyrock'. The Contractor shall use adequate, good quality stemming material. Wherever necessary, as determined by the Engineer, the covering of blasts, with blasting mats or adequate dirt cover will be required. The Engineer reserves the right at any time to reduce explosive amounts, change blasting patterns on any blasting, or eliminate blasting in certain areas should conditions warrant. Nothing presented herein in any way relieves the Contractor of any responsibility of any damage to the existing pipelines or other structures or utilities in the area of blasting.

F. Seismograph and Blasting Records: After completion of the test blasts, the Contractor shall provide a minimum of one (1) seismograph to measure and record ground motion caused by each subsequent blast detonated under the Contract. Vibration monitoring shall be in accordance with COMAR 08.05.21 Section D. The seismograph shall be attached or located immediately adjacent to the nearest structure or dwelling, or on top of the nearest pipeline, as approved by the Engineer. The seismograph equipment shall be capable of producing a permanent record of the three (3) components of ground motion in terms of particle velocity and the air blast in decibels. The instrument shall be capable of internal dynamic calibration. The record of each blast shall consist of the seismograph records identified by instrument number, location of the instrument positively identified, date, time and location of the blast, amount of explosive used, maximum explosive charge weight per delay period and all other data necessary to control the blasting operations. These records, as a formal report, shall be made available to the Engineer as required.

G. Rock Excavation Vibration Limits: Vibrations on the ground above the nearest pipeline or nearest structure (whichever is closer) shall not have any one (1) of the three (3) components of the peak particle velocity exceed one point zero inches (1.0″) per second.

H. Crossing Under Existing Pipelines: If rock removal is required when crossing under existing pipelines, a rigid steel or wood beam shall be provided to support the pipeline and the bearing points of this beam should be outside the forty-five foot (45') influence line from the nearest point of the blast. A wood buffer shall be placed below the existing pipeline (in addition to conventional blasting mats) in order to prevent damage to the pipeline by flyrock.

I. Blasting Adjacent to Utilities: Blasting shall not be performed closer than ten feet (10′) to existing water, gas, sewer or conduit utilities unless such facilities have been completely

exposed, definitely located, and then backfilled prior to the blast. In any case, blasting shall be no closer than two feet (2′) from accurately located existing utilities, ten inch (10″) or smaller diameter and no closer than five feet (5′) from utilities larger than ten inch (10″) diameter.

J. Vibration Monitoring:

1. Pre and Post Construction Surveys: For any method of rock removal, the Contractor shall conduct Pre and Post Construction Surveys to provide details of internal and external video and photographed inspection of all structures within one hundred fifty feet (150′) of any of the rock excavation operations. This inspection will be carried out by an independent firm experienced in such inspections who has been approved by the Engineer. These inspections shall be maintained in a permanent form as field notes accompanied by photographs recording all major defects, and made available in written form should a claim of alleged damage arise.
2. Rock Excavation Vibration Limits: Vibrations, which are recorded at the nearest existing structure or utility shall be limited as follows:

    a. A peak particle velocity (on any one (1) of the three (3) components) of:

        1) One point zero inch (1.0″) per second for structures less than fifty feet (50′) from the blast
        2) Five-tenths inch (0.5″) inch per second for structures than greater fifty feet (50′) from the blast

3. Since the existing buildings, structures and pipelines are, in many cases, very close to the blasting and rock removal area, very slight changes in any blasting variable will result in large changes in vibration intensities. Modification of the blasting method and reduction of the explosive weight per delay shall be used to ensure that the above limits are met.
4. Vibration monitoring will be required for all methods of rock removal. Even though there might be buildings, pipelines or other structures closer to the rock removal area than the monitoring location (for example, a dwelling foundation), the Contractor will not be relieved of responsibility for any damage sustained to the buildings, pipelines or structures. This means that the vibration levels shall not exceed one point zero inches (1.0″) per second peak particle velocity at the nearest structure, pipeline or outside the Construction limits regardless of the monitoring location.
5. Noise Limits: The maximum allowable noise level at any inhabited building may not exceed one hundred thirty (130) decibels peak when measured by an approved instrument having a flat frequency response over the range of six to two hundred (6 to 200) Hertz. The maximum allowable noise limit at any uninhabited building may not exceed one hundred forty (140) decibels. When blasting is of a continuing nature, one hundred twenty-four to one hundred thirty (124–130) decibels shall be within the caution range. When the noise levels are consistently within the caution range, the rock removal procedures shall be changed to reduce the decibel level on the next rock removal procedure.

3.7 RESTORATION

A. General

After the completion of backfilling, all materials not used therein shall be removed and disposed of in such a manner and at such point or points as shall be approved or directed by the Engineer; and all roads, sidewalks, and other places on the line of the Work shall be left free of debris, clean, and in good order. Said cleaning up shall be done by the Contractor without extra compensation; and if the Contractor shall fail to do such Work within one (1) week after receipt of notice, the Engineer may arrange to have the cleaning up done by others; and the cost shall be retained out of the monies due or to become due to the Contractor under the Contract.

B. Paved Areas

Roadways, sidewalks, curbs, combination curb and gutter, driveway aprons, and other paved surfaces removed or damaged by the Contractor's activities shall be replaced by the Contractor in accordance with 32 01 30.10, (Patch Existing Pavement and Reset Utility Services) or as directed by the Engineer. Provide temporary pavement as described in the aforementioned section.

C. Non-paved Areas

1. Immediately upon completion of the trench backfill and compaction as previously specified, the Contractor shall temporarily stabilize the area in accordance with the requirements of 01 35 34, (Environmental Protection Procedures).
2. Weather permitting, within fourteen (14) days after the completion of trench backfill and compaction, the Contractor shall permanently stabilize the area with seeding and mulching or sodding, as appropriate, as specified in 32 92 23.01, (Turf Establishment) and 32 92 23, (Sodding).

D. Street Signs, Fences, Shrubs, Trees, and Other Improvements

In addition to the requirements contained in 01 76 01, (Preservation and Restoration of Property, Trees, Monuments, Streams, Lakes, and Reservoirs), Fences shall be re-erected by the Contractor at locations designated by the Engineer. Materials not capable of being re-erected through no fault of the Contractor shall be replaced on a Change Order basis as provided for in 01 26 46, (Construction Change Orders and Directives) for materials only.

PART 4 MEASUREMENT AND PAYMENT

A. This Work will not be measured but the cost will be incidental to the applicable utility item. This Work includes all applicable excavation, sheeting, shoring, dewatering, hauling, invert paving, storing, rehandling of material, removal and disposal of excess and unsuitable material (above the planned sub-grade), tamped fill, forming bed or foundation, stone, gravel cradle, backfill, compaction and all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. No payment will be made for excavation and refill below planned trench sub-grade made necessary by default or negligence on the part of the Contractor. When authorized by the Engineer, in writing, payment for excavation below planned trench sub-grade to lower pipe

invert or remove unsuitable material and for refill material to restore trench sub-grade shall be made at the unit price Bid per cubic yard in the Proposal for Class 3 Excavation for Incidental Construction (refer to 31 23 16.17, (Excavation for Incidental Construction Class 3)) and at the unit price Bid per ton in the Proposal for select backfill (refer to 31 23 23.13, (Selected Backfill)) respectively, which price and payment shall include all materials, labor, tools, equipment, hauling, excavation, removal and disposal of unsuitable material, re-handling of material, backfilling, compacting, sheeting and shoring, pumping and all incidentals necessary to complete the Work, except that the Bid price for the latter of these items shall be for furnishing and placement of the refill material only.

C. When, due to field conditions, the Engineer authorizes (in writing) (1) the lowering of a pipe invert or (2) Class 3 excavation to remove unsuitable material, the additional excavation below planned trench sub-grade will be measured in cubic yards computed from field measurements of the extra depth below said planned sub-grade and the applicable trench width permitted for payment. Refill material to restore trench sub-grade will be measured in tons based on verified weights from delivery tickets.

D. In case the grade or elevation of any pipe is raised as to require a depth of trench less than that shown on the Plans, an equitable credit for the decrease in trench excavation shall be agreed upon, in writing, before proceeding with the Work of this item.

E. The Contractor will be paid only for such sheeting, sheet piling, braces, shores, etc., which are left in place by written order of the Engineer. Payment will be made for the actual cost of this timber at the current market price at the time it is purchased by the Contractor who shall submit to the Engineer receipted bills or other evidence, as the Engineer may require, to show the price paid for all timber on which the above mentioned payment is to be made. Payment will cover only the length and the amount of timber actually left in the ground except that when timber sheeting or timber sheet-piling is cut off payment will be made for the entire length driven, the same as if it had been left in place. No payment will be made for any timber sheeting, timber sheet-piling, braces, shores, etc., left in place unless specifically ordered by the Engineer, nor will any payment be made for cutting off, removing and otherwise handling such sheeting but all such costs and incidental Work shall be included in and covered by the unit price Bid for various pipe items in the Proposal.

E. Contingent trench backfill shall be measured in cubic yards compacted in place. The maximum width of trench for payment for the various sizes of pipe shall conform to the dimensions for trench width for specific pipe (size, etc.) and/or other type of utility being installed, as shown on the standard plates. The depth of trench shall be considered to be from the top of original ground or planned sub-grade or existing roadway sub-grade or as designated by the Engineer, whichever is lower, to the center line of the pipe. The space around inlets and manholes will not be measured, but shall be considered as an extension of the adjacent trench section.

F. Payment for “Contingent Trench Backfill” compacted in place shall be the unit price Bid per cubic yard which price shall include the disposal of unsatisfactory material, the furnishing, hauling and compacting of materials, tools, equipment, labor and all incidentals necessary to complete the Work.

31 24 00 EMBANKMENTS

31 24 10 EARTH SHOULDERS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing shoulders using earth as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

Refer to 31 24 13.10, Part 2, (Embankment and Subgrade).

PART 3 EXECUTION

Refer to 31 24 13.10, Part 3 and 31 23 13, Part 3.

PART 4 MEASUREMENT AND PAYMENT

Earth shoulders will not be measured but the cost will be incidental to the Contract Unit Price for the pertinent excavation item.

31 24 10.01 SHOULDER EDGE DROP OFF GRADING ADJUSTMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing the area adjacent to the outside edge of the shoulder to eliminate the shoulder edge drop off.

PART 2 PRODUCTS

2.1 MATERIALS

A. Crusher Run Aggregate CR-6 shall conform to 32 11 23.10, (Aggregate Base Course).

B. Bank Run Gravel Subbase shall conform to 32 11 23.10, (Aggregate Base Course).

C. Select Borrow shall conform to 31 23 16.12, Part 2, (Select Borrow Excavation).

D. Common Borrow shall conform to 31 23 16.12 Part 2, (Select Borrow Excavation).

E. Topsoil shall conform to 31 14 13.24, Part 2, (Topsoiland Subsoil).

F. Hot Mix Asphalt Millings or Grindings. Size of individual particles shall be less than two inches (2″) shall be as determined visually.

PART 3 CONSTRUCTION

A. When the outside edge of the shoulder exceeds two and one-half inches (2-1/2″) in height above the existing ground line, the wedge shaped area shall be filled and graded to a slope of four to one (4:1) or flatter. The material shall be compacted as specified in the Contract Documents or as directed by the Engineer. The grading adjustment shall be completed by the end of the day that the drop off is created and prior to opening to traffic.

B. The material, lines and grades, and the cross section shall be as specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

Crusher Run Aggregate CR-6, Bank Run Gravel Subbase, Select Borrow, Common Borrow, Topsoil, and Hot Mix Asphalt Millings or Grindings for Shoulder Edge Drop Off will be measured and paid for at the Contract Unit Price per ton, cubic yard or square yard, as specified in the Contract Documents. The payment will be full compensation for furnishing, hauling, placing, compacting, maintaining, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

31 24 13.10 EMBANKMENT AND SUBGRADE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing the embankment and subgrade of suitable material obtained from roadway, structure, borrow, and other excavation included in the Contract. The material shall be placed, processed, and compacted to the lines and grades specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Soils and soil aggregate mixtures used in the Construction of embankments shall conform to the common borrow requirements in 31 23 16.12, Part 2, (Select Borrow Excavation) unless otherwise specified in the Contract Documents.

B. Rock may be used in embankments, provided that individual pieces do not exceed twenty-four inches (24″) in any dimension. Larger size rocks may be wasted with the approval of the Engineer.

C. Frozen material is prohibited from being placed in embankments. It shall be stockpiled outside the Construction limits and reserved for future use. Any material that is wasted shall be replaced. Rehandling of excavated material and replacement of wasted material shall be at no additional cost to the City. Any material that freezes after being placed in the embankment shall not be covered until it has thawed.

D. Embankment Adjacent to Structures. The Engineer may require the use of specially selected materials adjacent to structures to insure good compaction or to protect the structure from damage. Rock is prohibited. Embankment material at locations of pile supported foundations shall be a type that piles may be easily driven through the embankment.

PART 3 EXECUTION

3.1 EMBANKMENT FOUNDATION

A. Foundation Material. The Engineer will inspect the foundation prior to the Construction of an embankment. Topsoil, root mat, or unsuitable material shall be removed to the depth directed by the Engineer.

B. Embankment Over Existing Pavement. When embankment is placed over existing pavement, the pavement shall be thoroughly broken up, scarified or removed as specified in the Contract Documents or as directed by the Engineer.

C. Test Rolling. When test rolling is specified in the Contract Documents or directed by the Engineer, the foundation shall be tested by rolling with a thirty-five (35) ton pneumatic tired roller, or as approved by the Engineer.

3.2 PLACING AND SPREADING

A. The material shall be placed in horizontal layers across the full width of the embankment. An adequate crown shall be maintained to provide drainage at all times. Side slopes shall be maintained at the specified slope throughout the progress of the Work.

B. Embankment on Unstable Ground. When embankment is to be constructed on wet and unstable ground that will not support the weight of the Construction equipment, the first layer of the fill may be constructed by depositing material in a layer no thicker than that required to support the equipment. Subsequent layers shall conform to the following paragraph.

C. Earth Embankment. Except as otherwise specified, no layer shall exceed eight inches (8″) compacted depth.

D. Rock Embankment.

1. In rock embankment the thickness of layers shall be determined by the size of the rock or a twenty-four inch (24″) maximum depth, whichever is less. The portion of the embankment less than six feet (6′) below the subgrade at the profile grade line shall be placed in layers not more than eight inches (8″) compacted depth, and these layers shall be filled solid and fully choked with spalls, rock dust, or earth. Each layer shall be filled and compacted before the next layer is placed.
2. The top of the rock material shall provide a uniform surface, determined by connecting with straight lines the points on the typical cross section which are nine inches (9″) below any median ditch invert and nine inches (9″) below the bottom of the pavement structure and then sloping downward and outward under the shoulders at the rate of three-quarters inch (3/4″) per foot to the outer slope of the embankment.

3. The remaining upper portion of the embankment, unless otherwise specified in the Contract Documents, shall be constructed of suitable earth, free from stones that would be retained on a three inch (3″) sieve.

3.3 BENCHING

When embankment is to be placed and compacted on hillsides or when new embankment is to be compacted against existing embankments, the slopes on which the embankment is to be placed shall be continuously benched where they are steeper than four to one (4:1) when measured at right angles to the roadway. The benching operation shall be done as the embankment is brought up in layers. Benching shall be a minimum width of five feet (5′). Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cut. Material conforming to embankment requirements cut from the benches shall be compacted along with the new embankment material at no additional cost to the City.

3.4 COMPACTION

A. Immediately after spreading of each layer, the material shall be compacted with compaction equipment approved by the Engineer. Rolling shall be done in a longitudinal direction along the embankment, beginning at the outer edges and progressing towards the center. The travel paths of traffic and equipment shall be dispersed over the width of the embankment to aid in obtaining uniform compaction.

B. Material one foot (1′) below the top of subgrade shall be compacted to not less than ninety-two percent (92%) of the maximum dry density as specified in American Association of State Highway and Transportation Officials (AASHTO) T 180. Material in the top one foot (1′) shall be compacted to not less than ninety-seven percent (97%) of the maximum dry density. In place density shall be determined by the Maryland Standard Methods of Tests (MSMT) 350 or 352. When necessary, the layer shall be wetted or dried in order to compact the layer to the required density. The resultant moisture content of embankment material, when finally compacted to required density, shall be within two (2) percentage points of optimum.

C. The Contractor shall provide a portland cement concrete compaction block having dimensions eighteen inches by eighteen inches by nine inches (18″ X 18″ X 9″) and weighing at least two hundred pounds (200 lbs). One (1), eighteen inch by eighteen inch (18″ X 18″) working face shall have a level broomed surface.

3.5 STABILITY OF EMBANKMENTS

The Contractor shall be responsible for the stability of all embankments in the Contract and shall remove and replace with acceptable material any embankment or portion thereof that has been constructed with unsuitable material. The Contractor shall remove and replace unstable material and remove and replace portions of the embankment that become unstable or displaced as the result of the Contractor's operations at no additional cost to the City.

3.6 PROTECTION OF STRUCTURES AND UTILITIES DURING CONSTRUCTION

The Contractor shall be responsible for protecting all structures and utilities from any damage in the handling, processing, or compacting of embankment or backfill material.

Particular care shall be exercised in the vicinity of arches, retaining walls, culverts and utility trenches to assure that no undue strain or movement is produced. In areas where rollers cannot be used, the embankment or backfill shall conform to 31 23 23.10, (Tamped Fill).

3.7 SUBGRADE

The subgrade shall be constructed and shaped to the specified cross section after all cuts; embankment and backfilling have been substantially completed. The subgrade shall be proof rolled as specified in paragraph 3.1 C.

3.8 MAINTENANCE

During Construction and after completion of the embankment and subgrade, the embankment and subgrade shall be maintained by the Contractor until finally accepted. Embankment and subgrade material that may be lost or displaced as a result of natural causes such as storms and cloudbursts, or as a result of unavoidable movement or settlement of the ground or foundation upon which the embankment and subgrade is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. The Contractor shall at all times maintain ditches and drains to provide adequate drainage. The travel paths of any traffic or Construction equipment on the embankment and subgrade shall be held to a minimum to avoid the displacement of material or formation of ruts. When ruts two inches (2″) or more in depth are formed in the subgrade they shall be removed by reshaping and recompacting.

PART 4 MEASUREMENT AND PAYMENT

A. Embankment, subgrade, and all necessary Work will not be measured but the cost will be incidental to the Contract Unit Price per cubic yard for the pertinent class of excavation. The payment will be full compensation for the formation, sprinkling, compacting, test rolling, shaping, scarifying, breaking or removing of the existing pavement, sloping, trimming, finishing, maintaining embankments and subgrade, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Replacement of material lost as a result of natural causes will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent class of excavation item or as directed by the Engineer.

C. Compaction by means of mechanical tampers or vibratory compactors will not be measured but the cost will be incidental to the pertinent class of excavation item.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

31 25 00.01 EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of the application of erosion and sediment control measures throughout the life of the project to control erosion and to minimize the sedimentation in

rivers, streams, lakes, reservoirs, bays, and coastal waters as specified in the Contract Documents or as directed by the Engineer.

B. Erosion and sediment control measures shall be applied to all disturbed areas. In addition, the Contractor shall identify all staging and stockpile areas and apply erosion and sediment control measures as approved by the Engineer.

C. The Contractor shall assign an employee to the project to serve in the capacity of Erosion and Sediment Control Manager (ESCM).

1.2 STANDARDS AND SPECIFICATIONS

The erosion and sediment control measures and devices shall be constructed in conformance with the latest Maryland Standards and Specifications for Soil Erosion and Sediment Control published by the Maryland Department of the Environment, Water Management Administration and all revisions thereof including the additions and modifications specified herein or in the Contract Documents. The Contractor shall keep a copy of the latest Maryland Department of the Environment (MDE) Standards and Specifications for Soil Erosion and Sediment Control on the site at all times.

PART 2 PRODUCTS

2.1 MATERIALS

A. Riprap. Shall conform to 31 37 00, 2.1, (Rip Rap)

B. Stone for gabions. Shall conform to 31 36 00, 2.1, (Gabions)

C. Hot Mix Asphalt. Shall conform to 32 12 16.13, (Plant Mix Asphalt Pavement)

D. Pipe. Shall conform to 33 41 00, 2.1, (Storm Utility Drainage Piping)

E. Gabion Wire. Shall conform to 31 36 00, 2.1, (Gabions)

F. Steel Plate. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

G. Welding Material. Welding materials shall conform to AASHTO AWS D1.5.

H. Fence Fabric for Super Silt Fence. Chain link fencing fabric shall be two inch (2″) mesh woven from coated No. 9 gauge wire. The ends shall have a knuckled selvage at the bottom and a barbed selvage at the top. The fabric shall conform to M 181. Type I fabric shall conform to Class C coating. The mesh shall be forty-two inches (42″) in height.

I. Seed, Mulch, Fertilizer, Soil Conditioner, Soil Stabilization Matting, and Other Materials for seeding and soil stabilization shall conform to the following:

1. Seed. Refer to 32 92 23.01, Part 2, (Turf Establishment).
2. Mulch.

a. Shredded Hardwood Bark. Shredded hardwood bark shall consist of the bark from hardwood trees which has been milled and screened to a

maximum four inch (4″) particle size and provide a uniform texture free from sawdust, toxic substances and foreign materials.

b. Wood Chips. Wood chips shall be produced by a wood-chipping machine and be composted. Wood chips shall be a maximum size of two inches by two inches by one-half inch (2″ X 2″ X 0.5″). Composted wood chips shall be free of toxic substances and any foreign materials.

c. Grading analysis shall be as follows:

SIEVE SIZE (inch)	MAXIMUM PERCENT PASSING BY VOLUME
2	100
1	30
0.5	10

d. Straw and Hay. Straw shall consist of thoroughly threshed cereal grains. Hay shall consist of forage grasses and legumes. Straw and hay shall be free of noxious weeds and weed seeds as specified in 32 92 23.01 Part 2 (Turf Establishment). Straw and hay shall be visually inspected to ensure that it is free from mold, foreign substances, plant parts of Canada Thistle, Johnson grass, or Phragmites and is in an air-dry condition suitable for placing with mulch blower equipment.

e. Wood Cellulose Fiber. Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics which will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form homogeneous slurry. The fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system. The slurry shall contain a green dye that provides easy visual inspection for uniformity of application. The manufacturer shall furnish certification (A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement). The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer showing conformance to the following:

WOOD CELLULOSE FIBER REQUIREMENTS	
Particle Length, inches	Approximately 1/2
Particle Thickness, inches	Approximately 1/16
Net Dry Weight Content	Minimum as stated on bag
TAPPI* T 509, pH	4.0 – 8.5
Ash Content, TAPPI* Standard T 413, % max	7.0
Water Holding Capacity, % min	90

* Technical Association of Pulp and Paper Industry.

1) The material shall be delivered in packages of uniform weight, which shall not exceed seventy-five pounds (75 lb) net weight and shall bear the name of the manufacturer, the net weight and a supplemental statement of the net weight content.

3. Fertilizer: Refer to 32 92 23, Part 2, (Sodding).
4. Soil Stabilization Matting: Refer to 32 91 16.16, Part 2, (Soil Stabilization Matting).

J. Straw Bales. Straw bales for erosion and sediment control shall conform to the Contract Documents and shall be approximately fourteen inches by eighteen inches by thirty-six inches (14″ X 18″ X 36″).

K. Geotextile, Class as specified. Geotextile shall conform to the 33 46 16.19, (Pipe Underdrains).

L. Two inch to three inch (2″ to 3″) Stone. Stone shall conform to M 43, No. 2.

M. Three quarters inch to one and one-half inch (3/4″ to 1-1/2″) Stone. Stone shall conform to M 43, No. 4.

N. No. 57 Stone. Stone shall conform to M 43, No. 57.

O. Soil Stabilization Matting will replace Erosion Control Matting and Geotextile Class SE will replace Filter Cloth and Geotextile Class C where they appear in the latest Maryland Standards and Specifications for Soil Erosion and Sediment Control.

PART 3 EXECUTION

3.1 GENERAL

Refer to 31 23 16.16, (Structure Excavation) for excavated material.

3.2 CONTRACTOR RESPONSIBILITIES

The Contractor shall construct all erosion and sediment control measures in conformance with paragraph 1.2. The Contractor shall have all control measures inspected and approved by the Engineer prior to beginning any other land disturbances. The Contractor shall ensure that all runoff from disturbed areas is directed via the sediment control measures. The Contractor shall not remove any erosion or sediment control measure without the approval of the Engineer. Refer to 01 35 43, (Environmental Protection Procedures) for unforeseen conditions.

3.3 EROSION AND SEDIMENT CONTROL PLAN (E & S PLAN) AND SEQUENCE OF CONSTRUCTION

The Contractor shall implement the City's E & S Plan and sequence of Construction as approved by the Engineer. Minor adjustments to the sediment control locations may be made in the field with the approval of the Engineer. Major revisions, deletions or substitutions to the E & S Plan will require a formal review and approval by the City. Changes to the approved E & S Plan shall be submitted to the City in writing at least fourteen (14) days prior to implementing the change. The Contractor shall obtain City approval for changes to the E & S Plan or sequence of Construction prior to implementing the change.

3.4 EROSION AND SEDIMENT CONTROL MANAGER (ESCM)

A. At least ten (10) days prior to beginning any Work, the name and credentials of the ESCM shall be submitted to the Engineer for approval. Any substitutes for the ESCM will be subject to the approval of the Engineer. The substitution shall be timed to ensure that an ESCM is assigned to the project at all times. The City reserves the right to request a reassignment of the ESCM duties to another individual for any reason.

B. The ESCM shall be thoroughly experienced in all aspects of Construction and have satisfactorily completed Erosion and Sediment Control Training Program either conducted or authorized by MDE pursuant to the appropriate article published in the Annotated Code for the State of Maryland. The ESCM shall have primary responsibility and authority for the implementation of the approved erosion and sediment control plans, schedules and methods of operation for both on-site and off-site activities.

C. The ESCM's duties shall include:

1. Inspect the erosion and sediment controls on a daily basis to ensure that all controls are in place at all times and to develop a list of activities and schedules to ensure conformance with the Contract Documents.
2. Maintain a daily log of these inspections, including actions taken and submit a written report to the Engineer at the end of the workday.
3. Conduct after storm inspections with the Engineer both during and beyond normal working hours/days and submit a written report to the Engineer.
4. Be assigned the authority by the Contractor to mobilize crews to make immediate repairs to the controls during working and nonworking hours.
5. When requested, accompany the Engineer on quality assurance inspections and inspections made by the regulating agencies.
6. Coordinate with the Engineer to ensure that all corrections are made immediately and that the project is in compliance with the approved plan at all times.

3.5 SCHEDULE

A. Within fourteen (14) days after the Notice of Award, the Contractor shall submit for approval to the Engineer erosion and sediment control schedule to implement the E & S plan. The schedule shall indicate the sequence of Construction, implementation and maintenance of controls, temporary and permanent stabilization, and the various stages of soil disturbance. The schedule is sent to the Engineer for approval. The schedule shall include the following:

1. Clearing and grubbing of areas necessary for installation of perimeter controls specified in the Contract Documents.
2. Construction of perimeter controls specified in the Contract Documents.
3. Remaining clearing and grubbing.
4. Roadway grading (including off-site Work).
5. If applicable, utility installation and whether storm drains shall be used or blocked after Construction.
6. Final grading, landscaping and stabilization.
7. Removal of perimeter controls.

B. No Work shall be started, on-site or off-site until the erosion and sediment control schedules and methods of operation have been accepted by the Engineer.

3.6 PRECONSTRUCTION CONFERENCE

At the Preconstruction Conference, the Contractor shall present a general overview of how erosion and sediment control measures will be implemented on the project.

3.7 MEETINGS

A. At least seven (7) working days prior to the start of Work, the Engineer will initiate and conduct an erosion and sediment control field meeting. The meeting shall be attended by the ESCM and representatives of the City.

B. In addition to the initial erosion and sediment control field meeting, periodic in-field erosion and sediment control meetings will be held to review and evaluate the effectiveness of measures already installed and to plan for the implementation of necessary controls proposed for succeeding areas of soil disturbance.

3.8 INITIAL CONTROLS

A. All perimeter controls such as silt fence, earth dikes/swales, check dams, traps, basins, etc., shall be installed prior to the grubbing operation. Typically no controls are required during the clearing operation.

B. If the Engineer determines that the clearing area has been disturbed and a potential for sediment runoff or erosion exists, the Engineer will direct the Contractor to install the controls at that time.

3.9 STABILIZATION REQUIREMENTS

A. Areas flatter than three to one (3:1) and stockpile areas shall be permanently or temporarily stabilized as soon as possible, but not later than fourteen (14) days after grubbing and grading activities have ceased in the area. Trap embankments and slopes, earth dikes, temporary swales, perimeter dike/swales, ditches and slopes three to one (3:1) or steeper shall be permanently or temporarily stabilized as soon as possible but not later than seven (7) days after grubbing and grading activities have ceased in the area. The seven (7) and fourteen (14) day requirements mean that the stabilization operation is complete within the applicable seven (7) or fourteen (14) day time frame.

B. When the excavation or embankment reaches the bottom of the subgrade, those areas in which paving will be placed are exempt from the stabilization requirements. Areas between temporary berms, except median areas, need not be stabilized during incremental stabilization. When permanently stabilized areas are disturbed by the Contractor's grading operation or other activities not specifically approved by the Engineer, the restabilization will be at no additional cost to the City. Stabilization requirements may be reduced to less than seven (7) days for sensitive areas. Maintenance shall be performed as necessary to ensure continued stabilization.

C. All slopes shall be tracked within five (5) days of establishment with cleated type equipment operating perpendicular to the slope.

3.10 MAINTENANCE

A. All erosion and sediment control devices shall be maintained during the Construction season, the winter months and other times when the project is shut down. Access shall be maintained to all erosion and sediment controls until the controls are removed. Lack of maintenance by the Contractor will be considered as noncompliance with the E & S Plan and grounds for a shutdown of the project.

B. Controls shall be inspected immediately following storm events. The Contractor shall repair controls when damaged and clean out controls as necessary as the first order of business after a storm event.

C. Any pumping activity, including dewatering sediment traps and basins, shall be directed through a dewatering device approved by the Engineer.

3.11 WASTE AREAS

Off-site waste areas on State or Federal property require MDE approval. All other off-site waste areas shall be approved by the Engineer. All waste areas and stockpile areas shall be protected by erosion and sediment control measures and stabilized within the seven (7) or fourteen (14) day stabilization requirement.

3.12 DEPARTMENT INSPECTIONS

The applicable department will conduct frequent field inspections relative to erosion and sediment control compliance. If they determine that noncompliance with erosion and sediment control provisions are found, their representative will immediately notify the Engineer relative to corrective action. This corrective action may require a shutdown of Construction activities until the noncompliance is satisfactorily corrected, and no claims against the City will be considered, due to a shutdown of the grading operations or the entire project.

3.13 SIDE OR BERM DITCHES AND CULVERTS

As a first order of Work, the Contractor shall construct the side ditches in fill areas and berm ditches in cuts including lining. These linings shall be protected from sediment deposits. Silt fence shall be placed along the banks of existing streams as shown in the Contract Documents prior to any culverts being placed. To avoid sedimentation during the Construction of culverts, the streams shall be diverted around the location of the culvert until the proposed culvert and channel have been stabilized.

3.14 REMOVAL OF CONTROLS

A. No erosion and sediment control measures shall be removed until all previously disturbed areas are vegetated with a minimum three inches (3″) growth of grass and the removal has been approved by the Engineer. The sediment controls shall be backfilled, graded and stabilized as specified in the Contract Documents.

B. All control devices shall be removed, except where an attempt to remove a particular control may severely disturb an area that has been stabilized. When a sediment trap or stone outlet structure is placed at the bottom of a fill greater than eight feet (8′), the

controls may be left in place as determined by the Engineer. Sediment traps left in place shall be stabilized by placing soil stabilization matting over a permanent seed mix.

3.15 EROSION AND SEDIMENT CONTROL ORIGINAL EXCAVATION

A. The Contractor shall excavate, construct embankments, grade and backfill for sediment traps, sediment basins and other sediment controls as specified in the Contract Documents or as directed by the Engineer.

B. Excavation and embankments shall be to the dimensions for each sediment control as specified in the Contract Documents. Excavated material shall be stockpiled and used for backfill when the sediment controls are removed.

3.16 EROSION AND SEDIMENT CONTROL CLEANOUT EXCAVATION

A. The Contractor shall remove accumulated sediment from sediment controls or other areas during routine maintenance of sediment controls or as directed by the Engineer.

B. Sediment traps shall be cleaned out as necessary to have a minimum of fifty percent (50%) of the wet storage capacity available at all times. Riprap outlet sediment traps shall have at least seventy-five percent (75%) of the wet storage capacity available at all times. Silt fence, super silt fence, stone outlet structures, stone check dams and straw bales shall have sediment removed when it reaches fifty percent (50%) of the height of the control device.

C. Sediment removed from control devices shall be placed in an approved waste site either on or off the project. Material stored on-site may be reused once it is dried and it conforms to City requirements for embankment.

3.17 EARTH DIKE

Stabilization using sod is prohibited.

3.18 TEMPORARY SWALE

Stabilization using sod is prohibited.

3.19 PERIMETER DIKE SWALE

Stabilization using sod is prohibited.

3.20 PIPE SLOPE DRAIN

Interceptor berms shall be constructed to direct flow into the flared end section when slope drains are placed on grade. The geotextile apron shall be keyed into a four inch by four inch (4″ X 4″) trench.

3.21 RIPRAP INFLOW PROTECTION

Gabions are prohibited.

3.22 GABION INFLOW PROTECTION

Construction shall be in conformance with 31 36 00, (Gabions)

3.23 STONE CHECK DAM

Spacing shall be as specified in the Contract Documents or as directed by the Engineer.

3.24 SEDIMENT TRAPS

A. Sediment traps shall be located and excavated to the length, width and depth as specified in the Contract Documents. In areas of limited right-of-way, cut side slopes shall be as steep as soil conditions will allow.

B. At sites where infiltration devices are used for the control of storm water, every precaution shall be taken to prevent runoff from unstabilized areas from entering the infiltration devices during Construction. Sediment control devices placed in infiltration areas shall have bottom elevations at least two feet (2′) higher than the finish grade bottom elevation of the infiltration device. When converting a sediment trap to an infiltration device, all accumulated sediment shall be removed and disposed of prior to final grading of the device.

C. When grading and paving operations have been completed and vegetation has been established on the slopes and channels to the satisfaction of the Engineer, the sediment traps shall be refilled with suitable materials, shaped and treated as specified in the Contract Documents or as directed by the Engineer.

3.25 STONE OUTLET STRUCTURES

The area beneath stone outlet structures shall be stabilized immediately after the removal of stone outlet structures.

3.26 REMOVABLE PUMPING STATION

The Contractor shall furnish the required standpipe, pump, hoses, and connections necessary to adequately dewater the site for Construction activities. A pit shall be excavated to the dimensions required to construct the removable pumping station.

3.27 SUMP PIT

The Contractor shall furnish the required standpipe, pump, hoses and connections necessary to adequately dewater the site for Construction activities. A pit shall be excavated to the dimensions required to construct the sump pit.

3.28 PORTABLE SEDIMENT TANK

The Contractor shall furnish the required pipe, pump, hoses and connections necessary to adequately dewater the site for Construction activities. The dimensions of the portable sediment tank shall be determined by the Contractor to provide the required storage volume per pump discharge.

3.29 SILT FENCE

A. The geotextile shall be embedded a minimum of eight inches (8″) vertically into the ground and extend a minimum of twenty-two inches (22″) above ground. The fence post shall be driven a minimum sixteen inches (16″) into the ground and extend a minimum twenty-six inches (26″) above the ground.

B. Silt fence shall be removed and reset when and as directed by the Engineer. All of the requirements for the original placement of the silt fence shall be strictly adhered to when the fence is reset.

3.30 INLET PROTECTION

Inlet protection shall consist of the Construction of standard inlet protection, at grade inlet protection, curb inlet protection or median inlet protection.

3.31 STABILIZED CONSTRUCTION ENTRANCE

A. Stabilized Construction entrances shall be located as specified in the Contract Documents or as directed by the Engineer.

B. Rehabilitate stabilized Construction entrance shall consist of periodic top dressing with additional aggregate, replacement of pipe or other repairs to the entrance and sediment trapping devices as needed or as directed by the Engineer.

3.32 SUPER SILT FENCE

A. The Construction requirements for the placement of the chain link fence shall be as specified in 32 31 13, Part 3, (Chain Link Fence) with the following exceptions:

1. Drive anchors shall be used when and as directed by the Engineer.
2. The lower tension wire, brace and truss rods, post caps, one inch (1″) ground clearance and concrete footings shall not be used.

B. Geotextile shall be embedded a minimum of eight inches (8″) into the ground and extend a minimum of thirty-three inches (33″) above ground.

C. Super silt fence shall be removed and reset when and as directed by the Engineer. All of the requirements for the original placement of the super silt fence shall be strictly adhered to when the fence is reset.

3.33 TEMPORARY ASPHALT BERM

When a storm drain system outfall is directed to a sediment trap or sediment basin and the system is to be used for temporarily conveying sediment laden water, all storm drain inlets in nonsump areas shall have temporary asphalt berms constructed as directed by the Engineer at the time of base paving to direct gutter flow into the inlets to avoid surcharging and overflow of inlets in sump areas.

3.34 STRAW BALES FOR SEDIMENT CONTROL

A. Straw bales shall be used for temporary control of erosion and sedimentation in side ditches or where the placement of a stone outlet structure is not practical. The use of straw bales in median ditches is prohibited.

B. Straw bales shall consist of undecayed firmly packed straw, approximate size fourteen inches by eighteen inches by thirty-six inches (14″ X 18″ X 36″) as prepared by a standard baling machine and firmly bound by at least two (2) separate circuits of rope or band material which will withstand weathering for the length of time the bale is functioning as a sediment control device. Binding tension on the baling machine shall be sufficient to produce a bale with voids no greater than the nominal thickness of the straw. The bales shall be embedded in soil to a depth of not less than four inches (4″) and shall be secured in place with two (2), No. 4 reinforcement bars, steel pickets or two inch by two inch (2″ X 2″) wood stakes, thirty-six inches (36″) in length. The bales shall be secured by locating the anchoring devices at approximate third points along the longitudinal centerline of each bale and driving the anchoring device through the bale and into the ground to a depth of one foot to one and five-tenths feet (1′ to 1.5′).

3.35 STONE FOR SEDIMENT CONTROL

The Contractor shall place No. 57 stone, three-quarters inch to one and one-half inch (3/4″ to 1-1/2″) stone, two inch to three inch (2″ to 3″) stone, four inch to seven inch (4″ to 7″) stone and riprap for sediment control as specified in the Contract Documents or as directed by the Engineer.

3.36 MAINTENANCE OF STREAM FLOW

A. During all operations, the Contractor shall maintain the continuous flow of waterways for the locations indicated in the Contract Documents.

B. Upon completion of Construction and after temporary drainage devices have served their purpose, the devices shall be removed and disposed of in a manner acceptable to the Engineer.

C. When the Contract Documents include details for the continuous maintenance of stream flow during Construction, a Temporary Stream Crossing Permit will not be required if the Contractor uses the Contract Documents and does no other Work in the waterways. The Contractor may develop a different plan for maintenance of stream flow, but approval from the Engineer and a Temporary Stream Crossing Permit will be required in these cases. A temporary stream crossing permit may be obtained by the Contractor from the Maryland Department of the Environment, Water Management Administration, Permits Services Center.

D. The application for the permit shall include the following items:

1. Permit Requirements.

a. Sequence of Construction phases such as channel and structure excavation, structure and embankment Construction.
b. Equipment crossings and storage areas.
c. Methods of maintaining stream flow.

d. Control of dewatering discharges.
e. Control of runoff for various phases preceding permanent stabilization.
f. Methods for controlling erosion and siltation of the waterway.
g. The Notice To Proceed with Construction on the structures at the waterway will not be issued until all the necessary permits are approved and received.
h. The Contractor is alerted that the special conditions contained in the permit will control the time Construction activity will be permitted in the stream.
i. The discharge of sediment-laden water from newly excavated areas directly into the waterways is prohibited.

2. Conditions. To minimize the effects of discharges of dredged or fill material, the following provisions required by the Department of the Army Nationwide Permit shall be adhered to:

a. That the discharge will not be located in the proximity of a public water supply intake.
b. That the discharges will not destroy a threatened or endangered species as identified under the Endangered Species Act or destroys or adversely modifies the critical habitat of these species. In the case of federal agencies, it is their responsibility to review its activities to determine if the action may affect any listed species or critical habitat. If so, the federal agency will consult with the Fish and Wildlife Service and the National Marine Fisheries Service.
c. That the discharge will consist of suitable material free from toxic pollutants in toxic amounts.
d. That the fill created by the discharge will be properly maintained to prevent erosion and nonpoint sources of pollutants.
e. That the discharge will not occur in a component of the National Wild and Scenic River System.
f. That the management practices listed herein shall be followed to the maximum extent practicable.

3. Management Practices.

a. Discharges of dredged or fill material into waters of the United States shall be avoided or minimized through the use of other practical alternatives.
b. Direct discharge in spawning areas during spawning seasons is forbidden.
c. Discharges shall not restrict or impede the movement of aquatic species indigenous to the waters or the passage of normal or expected high water flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters).
d. If the discharge creates an impoundment of water, adverse impacts on the aquatic system caused by the accelerated passage of water or the restriction of its flow shall be minimized.
e. Discharges in wetlands shall be avoided.
f. When working in wetlands heavy equipment shall be placed on mats.
g. Discharges into breeding and nesting areas for migratory waterfowl shall be avoided.
h. All temporary fills shall be removed in their entirety.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work. The maintenance, repair, resetting and final removal of all erosion and sediment control devices will not be measured, but the cost will be incidental to the Contract Price to construct the device unless otherwise specified in the Contract Documents.

B. Erosion and sediment control manager will not be measured but the cost will be incidental to erosion and sediment control items specified in the Contract Documents.

C. The implementation of the erosion and sediment control plan by the Contractor will not be measured but the cost will be incidental to the erosion and sediment control items specified in the Contract Documents.

D. Erosion and sediment control original excavation will be measured and paid for at the Contract Unit Price per cubic yard. The payment will also include excavation, backfill, and grading.

E. Erosion and sediment control cleanout excavation will be measured and paid for at the Contract Unit Price per cubic yard. The payment will also include excavation and disposal.

F. Earth dikes will be measured and paid for at the Contract Unit Price per linear foot. When four inch to seven inch (4″ to 7″) stone, temporary seeding and soil stabilization matting are required, they will be measured and paid for as specified in 32 92 19.01, Part 4.B, (Temporary Seeding, Temporary Wood Cellulose Mulching and Temporary Straw Mulching) and 32 91 16.16, Part 4, (Soil Stabilization Matting), respectively.

G. Temporary swales will be measured and paid for at the Contract Unit Price per linear foot. When four inch to seven inch (4″ to 7″) stone, temporary seeding and soil stabilization matting are required, they will be measured and paid for as specified in 32 92 19.01, Part 4.B, (Temporary Seeding, Temporary Wood Cellulose Mulching and Temporary Straw Mulching) and 32 91 16.16, Part 4, (Soil Stabilization Matting), respectively.

H. Perimeter dike/swales will be measured and paid for at the Contract Unit Price per linear foot. When temporary seeding and soil stabilization matting are required, they will be measured and paid for as specified in 32 92 19.01, Part 4.B, (Temporary Seeding, Temporary Wood Cellulose Mulching and Temporary Straw Mulching) and 32 91 16.16, Part 4, (Soil Stabilization Matting), respectively.

I. Pipe Slope Drain will be measured and paid for at the Contract Unit Price per linear foot. The payment will also include excavation, backfill, flared end section, geotextile, anchors, coupling bands, and pipe elbows. Outlet protection will be measured and paid for as specified in paragraph Z.

J. Riprap inflow protection as specified in paragraph Z.

K. Gabion inflow protection as specified in 31 36 00, (Gabions).

L. Stone check dam will be measured and paid for at the Contract price as specified in paragraph Z.

M. Sediment traps will be measured and paid for at the Contract Unit Price for one or more of the items listed below:

1. Erosion and Sediment Control Original Excavation as specified in paragraph D.
2. Corrugated Metal Pipe per linear foot.
3. Polyvinyl Chloride Pipe per linear foot.
4. Stone as specified in paragraph Z.
5. Inflow protection as specified in paragraphs J and K.

N. Stone outlet structure will be measured and paid for as specified in paragraph Z. The baffle board and stakes will not be measured but the cost will be incidental to the Contract price.

O. Removable Pumping Station will be measured and paid for at the Contract Unit Price per each. The payment will also include excavation, pipe, geotextile, wire mesh, steel plate, hose, pump and connections. No. 57 stone will be measured and paid for as specified in paragraph Z.

P. Sump Pit will be measured and paid for at the Contract Unit Price per each. The payment will also include excavation, pipe, geotextile, wire mesh, steel plate, hose, pump and connections. No. 57 stone will be measured and paid for as specified in paragraph Z.

Q. Portable Sediment Tank will be measured and paid for at the Contract Unit Price per each. The payment will also include pipe, geotextile, wire mesh, steel plate, hose, pump and connections.

R. Silt Fence will be measured and paid for at the Contract Unit Price per linear foot.

S. Remove and Reset Silt Fence will be measured and paid for at the Contract Unit Price per linear foot.

T. Inlet Protection will be measured and paid for at the Contract Unit Price per each.

U. Stabilized Construction Entrance and Rehabilitate Stabilized Construction Entrance will be measured and paid for at the Contract Unit Price per ton. When pipe is required, it will not be measured but the cost will be incidental to the Contract Price.

V. Super Silt Fence will be measured and paid for at the Contract Unit Price per linear foot.

W. Remove and Reset Super Silt Fence will be measured and paid for at the Contract Unit Price per linear foot.

X. Temporary asphalt berm will be measured and paid for at the Contract Unit Price per ton of Hot Mix Asphalt. The removal of the temporary asphalt berm will not be measured but the cost will be incidental to the Contract Price.

Y. Straw Bales will be measured and paid for at the Contract Unit Price per linear foot measured along the approximate centerline of the row of bales. Excavation and anchoring the straw bales will not be measured but the cost will be incidental to the Contract Price.

Z. Stone for sediment control will be measured and paid for at the Contract Unit Price per ton for the pertinent Stone for Sediment Control item. Geotextile, excavation and backfill will not be measured but the cost will be incidental to the Contract Price.

AA. Maintenance of Stream Flow will not be measured but will be paid for at the Contract lump sum price. The payment will also include diversion structures, sandbags, polyethylene sheeting, diversion pipes, pumps, hoses and connections.

BB. Temporary Wood Cellulose Mulch will be measured and paid for as specified in 32 92 19.01, Part 4.C, (Temporary Seeding, Temporary Wood Cellulose Mulching and Temporary Straw Mulching).

CC. Temporary Seeding will be measured and paid for as specified in 32 92 19.01, Part 4.B, (Temporary Seeding, Temporary Wood Cellulose Mulching and Temporary Straw Mulching).

DD. Seeding Roadside Areas will be measured and paid for as specified in 32 92 23.01, Part 4.B, (Turf Establishment).

EE. Seeding Median Areas will be measured and paid for as specified in 32 92 23.01, Part 4.B, (Turf Establishment).

FF. Overseeding Roadside Areas will be measured and paid for as specified in 32 92 23.01, Part 4.E, (Turf Establishment).

GG. Overseeding Median Areas will be measured and paid for as specified in 32 92 23.01, Part 4.E, (Turf Establishment).

HH. Sodding will be measured and paid for as specified in 32 92 23, Part 4.A, (Sodding).

II. Temporary earth berms and interceptor berms for incremental stabilization will not be measured but the cost will be incidental to the excavation items specified in the Contract Documents.

31 32 00 SOIL STABILIZATION

31 32 19.16 GEOTEXTILE SOIL STABILIZATION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing a layer of geotextile and a minimum of twelve inches (12″) of graded aggregate base to bridge unstable material and minimize the use of undercutting. This item shall only be used when specified in the Contract Documents or as directed by the Engineer. In extremely unstable areas, the Engineer may increase the thickness of the graded aggregate base material.

PART 2 PRODUCTS

2.1 MATERIALS

A. Graded Aggregate Base see 32 11 23.10, (Aggregate Base Course)

B. Geotextile for Subgrade Stabilization – Class ST

C. Securing Pins or Staples: Securing pins or staples shall have a minimum ten inch (10″) length and shall be designed to securely hold the geosynthetic in place during Construction.

PART 3 EXECUTION

3.1 TEST STRIP

In extremely unstable areas, the Engineer may direct that a test strip be constructed to determine the thickness of aggregate layer required to stabilize the area. The test strip shall be a minimum of one hundred feet (100′) in length and at least one (1) lane wide. The Engineer will determine the depths of aggregate to be used in the test strip. Based on the results of the test strip the Engineer will determine the thickness of aggregate to use in subsequent Construction.

3.2 GRADE PREPARATION

A. When geosynthetic stabilized subgrade using graded aggregate base is specified, the area where the geotextile is to be placed shall be cut to the depth shown on the Contract Documents or as directed by the Engineer.

B. The grade upon which the geotextile is to be placed shall be brought to the line, grade, and cross section specified. The grade shall be as smooth as practical and free of debris. Construction traffic on the grade shall be minimized. When ruts are formed by Construction traffic, they shall be removed by reshaping the affected area. The grade shall not be overworked and shall be approved by the Engineer prior to placement of the geotextile. Adequate surface drainage shall be maintained in conformance with 31 23 13, (Subgrade Preparation).

C. Compaction and moisture requirements for the underlying soil on which the geotextile is to be placed may be waived by the Engineer.

3.3 GEOTEXTILE PLACEMENT

A. Geotextile shall be placed on the prepared surface for the full width of the area to be treated. In areas where longitudinal underdrain is to be placed, the geotextile shall be placed up to the edge of the proposed longitudinal underdrain trench, but shall not be placed where the trench is to be excavated.

B. The geotextile shall be unrolled on the grade parallel to the base line without dragging it across the grade. Wrinkles and folds in the geotextile shall be removed by stretching and pinning.

1. The geotextile shall be overlapped a minimum of thirty inches (30″) at roll edges and ends. Overlaps at the end of the roll shall be in the direction of aggregate

placement with the roll being covered on top of the next roll. Roll ends and roll end overlaps shall be pinned a minimum of five feet (5′) on center. Roll edges and roll edge overlaps shall be pinned a minimum of fifty feet (50′) on center.

2. For curves the geotextile shall be folded or cut and overlapped in the direction of the turn. Folds in the geotextile shall be pinned a minimum of five feet (5′) on center. Damaged geotextile shall be repaired or replaced immediately as directed by the Engineer at no additional cost to the City. Geotextile patches shall be overlapped a minimum of three feet (3′) into undamaged geotextile.
3. Traffic, including Construction equipment, is prohibited on the bare geotextile.

3.4. AGGREGATE PLACEMENT

1. Placement of the graded aggregate base shall be in conformance with 32 11 23.10, (Aggregate Base Course) with the following exceptions:

   a. Placement and Spreading. Aggregate shall be placed within three (3) working days of geotextile placement. The graded aggregate base shall be placed as a single lift in the thickness required to provide the specified compacted depth. The graded aggregate base shall be placed by end dumping and spreading. Construction shall be parallel to the base line. Turning of Construction equipment on the graded aggregate base shall be kept to a minimum.
   b. Density Requirements. Immediately after placement, the graded aggregate base material shall be compacted to the required density. The top 6 inches (6″) of the graded aggregate base shall be compacted to a minimum density of ninety-five percent (95%) of maximum dry density with a moisture content equal to optimum moisture content plus or minus two percent (± 2%), unless otherwise directed by the Engineer. The optimum moisture content and maximum dry density shall be determined in conformance with T 180. In-place density shall be measured as specified in Maryland Standard Method of Tests (MSMT) 350 or 352. Compaction requirements will be waived for the graded aggregate base material below the top six inches (6″).
   c. Vibration. Graded aggregate base shall not be vibrated unless otherwise specified or directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

1. Geosynthetic Stabilized Subgrade Using Graded Aggregate Base will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for furnishing and placing the geotextile and graded aggregate base, compaction, test strip, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.
2. Excavation will be measured and paid for in conformance with 31 23 16.10, (Roadway Excavation Class 1, Class 1-A, Class 2).

31 35 00 SLOPE PROTECTION

31 35 23.14 CONCRETE SLOPE AND CHANNEL PROTECTION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of protecting slopes and channels with cast-in-place concrete and cutoff walls as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS.

A. Crusher Run Aggregate CR-6 shall conform to 32 11 23.10, (Aggregate Base Course).

B. No. 57 Aggregate shall conform to 32 11 23.10, (Aggregate Base Course).

C. Curing Materials shall conform to 03 30 00, Part 2.1, (Cast-in-Place Concrete).

D. Form Release Compound shall conform to 03 30 00, Part 2.1, (Cast-in-Place Concrete).

E. Concrete Mix No. 2 shall conform to 03 30 00, Part 2.1, (Cast-in-Place Concrete).

F. Welded Steel Wire Fabric shall conform to Refer to 32 13 13.33, Part 2.1, (Plain and Reinforced Portland Cement Concrete Pavements).

G. Joint Sealer shall conform to 03 30 00, Part 2.1, (Cast-in-Place Concrete).

H. Preformed Joint Fillers shall conform to 03 30 00, Part 2.1, (Cast-in-Place Concrete).

I. Roofing Paper. Roofing paper to be used in expansion joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weigh less than thirty-nine and eight-tenths (39.8) lb/100 ft^2 and shall not crack when bent ninety degrees (90°) over a one-half inch (1/2″) radius at room temperature.

J. Borrow. Borrow shall conform to 31 23 16.12, Part 2.1, (Select Barrow Excavation).

PART 3 EXECUTION

3.1 EXCAVATION

Excavation, including excavation for cutoff walls shall conform to 32 16 13.13, (Cast-n-Place Concrete Curbs and Gutters). Refer to 31 23 16.16, Part 3.2, (Structure Excavation) for excavated material.

3.2 CAST-IN-PLACE CONCRETE

Cast-in-place concrete slope protection shall be constructed in alternate strips so that Construction joints are all in one (1) direction and that tooled joints run perpendicular to the Construction joints. The result shall be a checkerboard pattern having squares not less than

three feet (3′) nor more than five feet (5′). The size of the squares and the size of squares around curved surfaces shall be as directed by the Engineer. Joints and cutoff walls shall be constructed as specified in the Contract Documents or as directed by the Engineer.

3.3 FORMS

Forms shall conform to 32 13 13.14, (Hot Mixed Asphalt or Concrete Sidewalks).

3.4 CONCRETING

Concrete mixing shall conform to 03 30 43, Part 3.2, (Production Plants). Volumetric batching and continuous mixing will be permitted on this Work. Areas subject to the infiltration of water shall be dewatered by methods acceptable to the Engineer prior to placing the concrete. The concrete shall be spread, tamped or otherwise consolidated to secure maximum density as it is placed. It shall be struck off with an approved screed to the elevation of the top of the forms. The surface shall have a broomed finish. Plastering of the surface is prohibited. All edges and joints shall be edged with a one-quarter inch (1/4″) edging tool.

3.5 COLD WEATHER CONSTRUCTION AND CURING

Refer to 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements) for cold weather Construction and for concrete curing.

3.6 BACKFILL

After the forms have been removed, backfill shall be placed and compacted as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all concrete, forms, excavation, curing, joint sealer and filler, backfill, compaction, disposal of excess or unsuitable material, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Concrete Slope and Channel Protection and Concrete Slope Protection for Streams will be measured and paid for at the Contract Unit Price per square yard of finished surface.

C. Cutoff Walls will be measured and paid for at the Contract Unit Price per linear foot.

D. The removal and disposal of unsuitable material below the subgrade will be measured and paid for at the Contract Unit Price per cubic yard for Class 2 Excavation. The payment will include the cost of replacing the unsuitable material with suitable material acceptable to the Engineer except as specified in 03 47 12, Part 4, (Concrete Ditches).

E. When Borrow or Selected Backfill using No. 57 Aggregate or Selected Backfill using Crusher Run Aggregate CR-6 is approved by the Engineer as replacement material for the Class 2 Excavation, it will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent item specified in the Contract Documents.

31 35 26 CONTAINMENT BARRIERS

31 35 26.24 RIPRAP SLOPE AND CHANNEL PROTECTION

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of protecting slopes and channels with a covering of geotextile and stone and an aggregate filter blanket as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

1.2 MATERIALS

A. Aggregate Filter Blanket: Crusher Run Aggregate CR-6 refer to 32 11 23.10, (Aggregate Base Course).

B. Riprap: The stone shall be field or quarry stone of approved quality and may be certified from a source previously approved. The maximum dimension shall not exceed four (4) times the minimum dimension.

1. Stone for Riprap: Stone for riprap shall be uniformly graded from the smallest to the largest pieces as specified in the Contract Documents. The stone will be accepted upon visual inspection at the point of usage and shall conform to the following:

CLASS OF RIPRAP	SIZE	PERCENT OF TOTAL BY WEIGHT
0	Heavier than 33 lb Heavier than 10 lb Less than 1 lb	0 50 10 max
I	Heavier than 150 lb Heavier than 40 lb Less than 2 lb	0 50 10 max
II	Heavier than 700 lb Heavier than 200 lb Less than 20 lb	0 50 10 max
III	Heavier than 2000 lb Heavier than 600 lb Less than 40 lb	0 50 10 max

Note: Optimum gradation is fifty percent (50%) of the stone being above and fifty percent (50%) below the midsize. Reasonable visual tolerances will apply.

2. Stone for Channels and Ditches: Stone for channels and ditches shall conform to the size requirements of Class I Riprap and the following:

QUALITY REQUIREMENTS	
TEST AND METHOD	**SPECIFICATION LIMITS**
Apparent Specific Gravity T 85, min	2.50
Absorption T 85, % max	3.0
Sodium Sulphate Soundness - 5 cycles, 2-1/2 to 1-1/2 inches Aggregate T 104, % loss max	20

3. Stone for Slopes: Stone for slopes shall conform to M 43, size number 1 omitting T 11. The stone shall also conform to the quality requirements specified in 2.1A2.

C. Geotextile: Class as specified. Geotextile shall conform to 33 46 16.19, (Pipe Underdrains and Outlets).

PART 3 EXECUTION

3.1 EXCAVATION

Excavation for riprap and cutoff walls shall conform to the lines and grades specified in the Contract Documents. The subgrade shall be smooth and firm, free from protruding objects that would damage the geotextile and constructed in a manner acceptable to the Engineer. Refer to 31 23 16.16, (Structure Excavation (Class 3)) for excavated material.

3.2 GEOTEXTILE PLACEMENT

The geotextile shall be placed on the prepared subgrade with the adjacent edges overlapping a minimum of two feet (2'). Damaged geotextile shall be replaced or repaired at no additional cost to the City in a manner acceptable to the Engineer.

3.3 AGGREGATE FILTER BLANKET

When an aggregate filter blanket is specified, it shall conform to the lines and grades specified in the Contract Documents and shall be compacted in a manner acceptable to the Engineer.

3.4 RIPRAP PLACEMENT

A. The ground surface upon which the slope and channel protection is placed shall be free of brush, trees and stumps and shall be acceptable to the Engineer.

B. The first section of riprap placed shall consist of a minimum of five (5) tons and will be inspected by the Engineer for conformance to gradation and placement requirements. This section shall be used to evaluate quality control for the remainder of the project if it is approved by the Engineer. If the material is rejected, it shall be removed from the project and additional sections, each consisting of a minimum of five (5) tons, shall be placed.

C. The placement of the riprap shall begin with the bottom cutoff walls or toe sections. The larger stones shall be placed in the cutoff walls and along the outside edges of the limits of slope and channel protection. The riprap shall be placed with equipment, which produces

a uniformly graded mass of stones. Placing the stones by methods that cause segregation is prohibited.

D. The surface elevation of completed riprap installations shall be flush with adjacent channel bed or bank slope elevations and shall not create an obstacle to the flow. The outer riprap surfaces shall be even and present a generally neat appearance. The plus or minus tolerance of the surface of the finished riprap installation shall be three inches (3″) for Class I Riprap and six inches (6″) for Class II and III Riprap from the lines and grades shown on the Contract Documents when measured perpendicular to the exterior surface of the stonework.

E. Placed material not conforming to the specified limits shall be removed and replaced as directed by the Engineer at no additional cost to the City.

F. The stone shall be placed and distributed so the resulting layer will contain a minimum of voids and there will be no pockets of same size material. The stone shall be placed to its full course thickness in one (1) operation in a manner that the underlying material will not be displaced or worked into the course of riprap being placed. When an aggregate filter blanket is used, placement of the riprap shall proceed in a controlled manner to avoid disruption or damage to the layer of bedding material.

3.5 BACKFILL

Any excavation voids existing along the edges of the completed slope and channel protection shall be backfilled and compacted in a manner acceptable to the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, geotextile, stone, backfill, compaction, disposal of excess material, prewashing when required, preparation of quality control section and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. Riprap Slope and Channel Protection will be measured and paid for at the Contract Unit Price per square yard. Area measurements will be actual surface measurements.

C. Cutoff Walls will be measured and paid for at the Contract Unit Price per linear foot.

D. Riprap for scour protection will be measured and paid for at the Contract Unit Price per ton for the item Class II Riprap for scour protection.

31 36 00 GABIONS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of protecting slopes and channels with stone filled wire baskets as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stone: Stone for gabions shall conform to the quality requirements specified in 31 35 26.24, (Riprap Slope and Channel Protection) and the following, except that the loss by sodium sulfate shall not be greater than twelve percent (12%).

Table A	
DEPTH OF BASKET inches	**SIZE OF INDIVIDUAL PIECES* inches**
6	3 – 6
9	4 – 7
12	4 – 7
18	4 – 7
36	4 –12

*Size of pieces will be determined visually.

B. Wire for Gabions: The wire shall have a minimum tensile strength of sixty thousand (60,000) psi when tested as specified in A 370. All wire sizes and mesh spacing shall be as recommended by the manufacturer. Tie and connecting wire shall also conform to this Specification.

C. Stainless steel interlocking fasteners may be substituted for wire ties. The fasteners shall conform to A 313. When subjected to directional tension along its axis, the fastener shall remain in a closed and locked condition for a minimum force of nine hundred pounds (900 lbs.).

D. Galvanized Coating for Gabions: Galvanized coating for fabric, ties and connecting wire shall not be less eight tenths (0.8) oz/ft^2 when tested as specified in A 90.

E. Polyvinyl Chloride (PVC) Coating for Gabions: PVC coating for fabric, ties and connecting wires for gabions shall exhibit no weight loss when tested as specified in Maryland Standard Methods of Tests (MSMT) 508. Color shall conform to federal standards and shall match throughout the project.

F. Geotextile: Class as specified. Geotextile shall conform to 33 46 16.19, (Pipe Underdrains and Outlets).

PART 3 EXECUTION

3.1 EXCAVATION

Excavation, including excavation for cutoff walls, shall conform to the lines and grades specified in the Contract Documents. The subgrade shall be smooth, firm and free from protruding objects or voids that would affect the proper placement of the wire baskets or damage the geotextile. Refer to 31 23 16.16, (Structure Excavation) for excavated material.

3.2 GEOTEXTILE

Geotextile shall be required for all gabions and shall be placed on the prepared subgrade. Adjacent strips shall be overlapped a minimum of two feet (2'). Care shall be exercised in placing and anchoring the empty basket units to ensure proper alignment and to avoid damaging the geotextile. Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the City.

3.3 WIRE BASKETS

Placement of the units shall begin with the cutoff walls. The empty units shall be set on the geotextile and the vertical ends bound together with wire ties or interlocking fasteners spaced to permit stretching of the units to remove kinks. Stretching methods will be optional with the Contractor. Stakes, pins or other approved methods shall be used to ensure a proper alignment.

3.4 STONE

The empty basket units shall be filled carefully with stone placed by hand or machine to ensure good alignment with a minimum of voids between stones, avoiding bulging of the mesh. The maximum height from which the stone shall be dropped into the units shall be thirty-six inches (36″). The stone shall be placed to provide a minimum of two (2) courses. Care shall be taken in placing the top layer of stone to ensure a uniform surface to avoid any bulging of the lid mesh. After a basket unit has been filled, the lid shall be bent over until it meets the ends of the unit. The lid shall then be secured to the sides and ends with wire ties or interlocking fasteners. When a complete basket unit cannot be installed on slopes or channels because of space limitations, the basket unit shall be cut to fit as directed by the Engineer.

3.5 BACKFILL

Any excavation voids existing along the edges of the completed gabions shall be backfilled and compacted in a manner acceptable to the Engineer.

PART 4 MEASUREMENT AND PAYMENT

Gabions, including cutoff walls, will be measured and paid for at the Contract Unit Price per cubic yard of stone filled wire baskets complete in place. The payment will be full compensation for all excavation, geotextile, stone, ties or fasteners, backfill, compaction, disposal of excess material and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

31 37 00 RIPRAP

31 37 00.01 RIPRAP DITCHES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing riprap ditches and riprap ditches with capping as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Riprap shall conform to 31 35 26.24, (Riprap Slope and Channel Protection).

B. Geotextile, Class as specified. Geotextile shall conform to 33 46 16.19, Part 2, (Pipe Underdrains and Outlets).

C. Two inch to four inch (2″ to 4″) stone. Stone shall conform to M43, No.1.

PART 3 EXECUTION

3.1 EXCAVATION

Excavation shall conform to the line and grade specified in the Contract Documents. Ditch sides and bottom shall be smooth and firm, free from protruding objects that would damage the geotextile and constructed in a manner acceptable to the Engineer. Refer to 31 23 16.16, Part 3, (Structure Excavation) for excavated material.

3.2 GEOTEXTILE PLACEMENT

The geotextile shall be placed on the prepared subgrade with the adjacent edges overlapped a minimum of two feet (2′). Damaged geotextile shall be replaced or repaired at no additional cost to the City in a manner acceptable to the Engineer.

3.3 RIPRAP PLACEMENT

Stones shall be placed by mechanical or other acceptable methods to produce a reasonably graded mass of stone. Placing the stones by methods that cause extensive segregation is prohibited. The depth of the riprap shall be as specified in the Contract Documents.

3.4 BACKFILL

Any excavation voids existing along the edges and ends of the placed riprap shall be backfilled with suitable material to blend in with contiguous slopes, ditch lines or existing ground. Riprap placed in the clear recovery area shall be capped with a layer of two inch to four inch (2″ to 4″) stone.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, geotextile, stone, backfill, and disposal of excess material and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. Riprap Ditches and Riprap Ditches with Capping will be measured and paid for at the Contract Unit Price per square yard of finished surface.

C. Bottom Cutoff Walls and Side Cutoff Walls will be measured and paid for at the Contract Unit Price per linear foot.

31 62 00 SPECIAL FOUNDATIONS AND LOAD-BEARING ELEMENTS

31 62 00 DRIVEN PILES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing piling as specified in the Contract Documents or as directed by the Engineer. Drilled shafts (caissons) are covered under a separate specification section.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sand as a fine aggregate including natural and manufactured sand, shall conform to the following:

TABLE A – FINE AGGREGATE GRADING REQUIREMENTS TEST METHOD T 27

SIEVE SIZE									
3/8″	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
100	95–100	—	—	45–85	—	—	10–30	0–10	—

TABLE B – FINE AGGREGATE PHYSICAL PROPERTY REQUIREMENTS (a)

	TEST METHOD				
SPECIFICATION	T 104	T 112	T 11	T 113	T 21
	SODIUM SULFATE SOUNDNESS % max	CLAY LUMPS & FRIABLE PARTICLES % max	MATERIAL FINER THAN No. 200 SIEVE % max	COAL & LIGNITE % max	ORGANIC IMPURITIES max
M 6 CLASS B	10	3.0	4.0(b)	1.0	3.0

Note: (a) Fine aggregate shall be tested for alkali silica reactivity (ASR) as specified in MSMT 212.

Note: (b) Five point zero (5.0) for concrete not subject to surface abrasion

B. Concrete for Steel Pipe Piles shall conform to the Mix No. 3 with 28 days strength of 3500 psi and slump range of two inches to five inches (2″–5″).

C. Tremie Concrete for Steel Pipe Piles shall conform to the Mix No. 4 with twenty-eight (28) days strength of thirty-five hundred (3500) psi and slump range of four inches to eight inches (4″–8″).

D. Timber Piling: Timber piles and timber sheet piles shall conform to M 168.

E. Resin and Fiberglass Caps for Timber Pile Heads: Resin and fiberglass for use in protecting timber pile heads shall conform to the following:

PROPERTY	SPECIFICATION LIMITS	TEST METHOD
MOISTURE INSENSITIVE RESIN		
Tensile Strength, psi, min	5000	D 638
Tensile Elongation, % min	0.05	D 638
Compressive Strength, psi, min	9000	C 109
Abrasive Resistance, *1/mil, min	60	D 968
WOVEN GLASS CLOTH		
Weight, oz/yd^2, min	9	—
Type	Volan A	—

*liters (l) of fine aggregate per mil thickness of resin

F. Steel Pipe Piles: Steel pipe piles shall conform to A 252, Grade 2.

G. Steel H Piles: Steel bearing piles and steel bearing pile splice material shall conform to A 36.

H. Steel Sheet Piles: Steel sheet piles shall conform to A 328. Sheet pile accessories shall conform to A 36. High strength bolts, nuts and washers shall conform to A 709, Grade 36.

I. Reinforcement for Steel Pipe Piles: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy coatings shall conform to D 3963.

J. Hardware: Spikes, wood screws, staples, brads, lag screws, carriage bolts, and other parts under the general heading of “Hardware” shall be composed of carbon steel and shall conform to federal specification FF-N-105.

K. Water: Water for concrete mixes shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed one thousand (1000) ppm limit.

L. Timber Preservatives: Preservatives and pressure treatment for timber shall conform to M 133.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall be responsible for ordering and delivering piling of the proper type and length to the structure site.

3.2 STORAGE AND HANDLING

Piling shall be stored and handled to avoid damage. Damaged piling shall be repaired or replaced as directed by the Engineer.

3.3 PREPARATION FOR DRIVING

A. Piling shall not be driven until embankments and excavation have been completed as specified in the Contract Documents or as directed by the Engineer.

B. The Contractor shall provide templates or other approved means to assure that the piles are properly aligned and positioned.

C. The heads of all piling shall be equipped with a cap or cushion so that the energy imparted by the hammer can be transmitted to the pile evenly without injury to the top or butt. The top of the pile, irrespective of its type, shall be normal to the axis of the moving parts of the hammer.

3.4 PILE TIPS

A. Timber piles shall be pointed where driving conditions require. The point shall be symmetrical and not less than a four inch (4″) diameter. Timber piles shall have their tips or bottoms shod with a metal shoe or point when specified in the Contract Documents or as directed by the Engineer.

B. Timber sheet piling shall be drift sharpened or beveled at the bottom to wedge contiguous piles in tighter contact.

C. Steel H piles shall be driven without any special tip reinforcement unless otherwise specified in the Contract Documents.

D. Steel pipe piles shall be driven open ended.

3.5 SPLICING

A. Splicing of timber piles is prohibited. In event of an isolated timber pile penetrating below planned tip elevation resulting in the top being below planned elevation, the Engineer will determine when replacement is required, supplemented by an additional pile or when the structure can be changed without detriment.

B. When splicing of steel H piles and steel pipe piles is necessary, they shall be spliced as specified in the Contract Documents by electric arc welding conforming to American Welding Standards (AWS) Structural Welding Code for the full periphery. The number of splices permitted shall be compatible with driving conditions at the site and the standard

lengths of piling produced by manufacturers; however, only one (1) section of each pile shall be less than twenty feet (20′).

C. When welding is required above a maximum elevation specified in the Contract Documents, it shall be performed in conformance with “Structural Steel Framing” 05 12 00, excluding the submerged arc welding requirement.

D. All welding above these limits shall receive one hundred percent (100%) Magnetic Particle Inspection (MT) on the root pass and completed weld, and one hundred percent (100%) Radiographic Inspection (RT), in conformance with AWS D1.5. Inspectors shall be approved by the Office of Materials and Technology Metals Group as specified for certification testing in conformance with AWS D1.5.

E. Inspectors certified by an accredited/certified American Society for Non-Destructive Testing (ASNT) Level III in the inspection discipline, may submit certifications to the Office of Materials and Technology Metals Group for review.

F. Where a manufactured pile type is designed to be spliced by screwing two (2) pieces together or by the use of couplings or collars, and the details for the splice are not specified in the Contract Documents, the device shall be submitted to and approved by the Engineer before use.

G. It is intended, when practical, that piles are driven in a continuous operation, and that splicing be performed prior to approaching the estimated tip elevation.

3.6 TEST PILING

The depth of penetration and the length of piling for structures will generally be determined by driving test piles. The Contract Documents will specify the test pile locations, minimum penetrations, bearing values and estimated tip elevations. From this information, the Contractor shall order and drive the test piling. The actual safe bearing value of the test piling can then be determined as specified in the following part of the Specifications. From the test pile data and observed behavior, the Contractor shall order the permanent piling required to complete the Work.

3.7 PILE DRIVING

A. The Contractor shall submit to the Engineer, a plan of the pile driving method, including the type of hammer, for approval prior to driving any piling.

B. The hammer to be used for driving permanent piles shall be the same hammer that was used to drive the test piles. If the Contractor changes the hammer, the Contractor shall drive additional test piles at no additional cost to the City, before driving the permanent piles, even if the energy ratings of the hammers are identical.

C. Hammers shall be operated at speeds recommended by the manufacturer for the bearing value specified. The manufacturer’s manual for the hammer employed shall be available to the Engineer at the project site.

D. Hammer energy is defined for the purpose of these Specifications as the approved rated energy per blow of the power hammer.

E. Tests will be directed by the Engineer to determine the acceptability and energy rating of power hammers. The Contractor shall pay all costs, including the City's expenses, for approval and energy rating of any pile driving hammer.

F. When considering the hammer for approval, the ratio of the weight of the pile to the weight of the striking unit will be evaluated to determine the adequacy of the hammer.

G. Leads or spuds shall be constructed to afford freedom of movement of the hammer during the driving phases. The Contractor shall drive the piles within the tolerance as specified without injury to the piles. Any leads that do not produce satisfactory end results in the driving of piling shall be removed from the Work.

H. Driving with the hammer out of the leads is prohibited.

I. On all special, marine or water projects and pile bents, the leads shall be of sufficient length so that the use of a follower will not be necessary. Long piles and batter piles may require guides at intervals and additional support to prevent excessive bending or buckling under the hammer blow. Piles shall be held in place and alignment by templates or other means approved by the Engineer.

J. External jetting of any piles is prohibited. If it is necessary to remove material from within a pile shell to advance the pile tip or merely to obtain room for concreting, a minimum of ten feet (10′) soil plug shall be left undisturbed at the tip of the pile. Turbidity curtains shall be installed around the piles being cleaned.

K. Where piling must perforate strata, which resists driving, the Contractor shall auger or drill holes through the strata. The size of the auger or drill to be used shall not be larger than the nominal diameter of a round pile or the minimum diameter of a circle in which an H pile will fit and shall be approved by the Engineer before use. After the hole is completed, the pile shall be inserted and dry sand shall be used to completely fill any voids between the pile and the walls of the hole. Driving shall then be completed, after which any remaining voids shall be completely filled with dry sand.

3.8 PILE DRIVING TOLERANCES

A. General: Foundation piles shall not be used out of the position specified in the Contract Documents by more than six inches (6″) in any direction after driving, regardless of the length of piles. Variation from the vertical or from the batter shall not be more than one-quarter inch (1/4″) per foot.

B. H Piles: Rotation of the pile in excess of twenty five degrees (25°) from the as planned axis is prohibited.

C. Bents: Piles shall be driven so that the cap may be placed in its proper location.

3.9 UNACCEPTABLE PILES

A. Any pile not in conformance with the Contract Documents shall be corrected by one of the following methods or other methods approved by the Engineer at no additional cost to the City:

1. The pile shall be withdrawn and replaced by a new pile.
2. A second pile shall be driven adjacent to the unacceptable pile.
3. The pile shall be spliced or built up (except timber piles).
4. A sufficient portion of the footing shall be extended to properly embed the pile.

3.10 BEARING VALUE

A. The determination of the bearing value shall be primarily obtained from observation and reporting of the behavior of the test pile from the time first placed in the leads until it attains practical refusal or reaches a stratum specified in the Contract Documents or as directed by the Engineer. To furnish the Engineer and Contractor with a guide as to the probable supporting value at each position, the Engineer will compute the safe bearing value from the following formula:

$$P = \frac{2WH}{S + 0.1}$$ for single acting power hammers

$$P = \frac{2E}{S + 0.1}$$ for double acting power hammers

where:

P	=	safe bearing value in pounds.
H	=	height of fall in feet.
W	=	weight in pounds of striking parts of hammer.
E	=	approved hammer energy per blow in foot pounds for double acting, differential acting, and diesel hammers.
S	=	the average penetration in inches per blow for the last several inches of penetration.

The above formula is applicable only when:

1. The hammer is operating properly and at the manufacturer's recommended speed in the case of a power hammer.
2. The head of the pile is not broomed or crushed.
3. The penetration is reasonably quick and uniform.
4. There is no discernable bounce after the blow.
5. A follower is not used.

B. If the Contract does not provide for test loading, the results of this formula as applied to the test piles shall be used to designate the proposed penetration or lengths of piles. However, each pile shall have its driving record evaluated to assure its ability to carry the intended load.

C. Test piles shall be driven in permanent vertical pile locations as directed by the Engineer or as specified in the Contract Documents. Test piles found to be satisfactory by the Engineer shall be utilized as permanent piles.

3.11 PILE CUTOFF AND REMOVAL

A. The tops of all piles and pile casings, except timber piles that support timber caps, shall be cut off at the elevations specified in the Contract Documents and on a true plane perpendicular to the axis of the pile unless otherwise specified. Timber piles that support timber caps shall be cut off to ensure that the plane of the bottom of the cap will bear fully on the pile head. Shimming between the timber cap and pile head is prohibited.

B. Piles used for sheeting and shoring shall be cut off a minimum of one foot (1′) below existing grade, channel bottom or mud line as applicable. When specified in the Contract Documents, these piles may be removed. The Contractor shall dispose of all removed material on approved spoil areas.

3.12 STEEL PIPE PILES

A. After driving, soil plugs shall be removed to the elevation specified in the Contract Documents. Prior to placing filling (when specified) or reinforcement, steel pipe piles shall be inspected with the aid of a suitable light for illuminating the interiors of the piles for their entire unplugged length. No filling or reinforcement shall be placed until the Engineer approves the pile.

B. The Contractor shall provide all required equipment for inspection including oxygen, light, boatswain's chair and lift. The Contractor shall comply with federal and local safety regulations while performing this Work.

3.13 CONCRETING STEEL PIPE PILES

A. Concrete Work shall conform to 03 30 00, (Cast-in-Place Concrete). Reinforcement shall conform to 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavement) and shall be securely fastened together to form a cage which shall be positioned and held at a uniform distance from the shell.

B. Tie bars and bands for reinforcement cages of foundation (footing) piles shall be tie wired. Tack welding may be used, provided a City certified welder is used.

C. Tie bars, bands and spacer lugs for bents or column piles shall not be tack welded to any of the main reinforcement bars except that the Contractor may place a band at the top and bottom of the pile cage and weld all main bars to the band. The remainder of the intersections of ties and main bars shall be fastened by tie wiring.

D. The top portion of the pile shall be cleaned in the areas to be filled with reinforced concrete and tremie concrete as shown on the Contract Documents. Tremie concrete shall be placed and cured prior to dewatering the top of the pile shell. The reinforcement unit shall be placed in the top portion of the pile prior to filling with Mix No. 3 concrete. All Work shall conform to the Contract Documents as directed by the Engineer.

E. Concrete shall not be placed in any pile until all driving within a radius of fifteen feet (15′) has been completed or until all the piles for any unit of the structure (pier, bent or abutment) have been driven to their final penetration and accepted by the Engineer. In the event that this procedure cannot be followed, all driving within the above limits shall be discontinued until the concrete in the last pile placed has set a minimum of seventy-two (72) hours.

F. Immediately prior to concreting, water or other foreign substances found in a pile shall be removed. The concrete shall be deposited in one (1) continuous operation.

G. Reinforcement steel cages shall be set and fastened in proper position in the pile before any concrete filling is placed, except when the reinforcement steel cage extends six feet (6′) or less below the top of the pile, the concrete filling may be placed before the reinforcement is installed. Concrete deposited in piles shall be thoroughly consolidated with mechanical vibrators from the bottom of the reinforcement steel cages to the tops of piles.

H. Freshly concreted piles shall not be disturbed in any way nor shall any loads be allowed upon any of them until all concrete has been in place and cured a minimum of seventy-two (72) hours.

3.14 TREATMENT FOR TIMBER PILE HEADS

Timber pile heads that are not to be imbedded in concrete shall be painted with an approved asphalt treatment. After the asphalt has sufficiently cured, it shall be covered with a glass resin composite shield. The first coat of resin shall be applied to the top and down the side a minimum of one inch (1″) beyond the limits of the woven glass. Precut woven glass cloth shall be applied using a three inches (3″) grooved aluminum roller to achieve “wet out”. Woven glass cloth shall be neatly wrapped over the top of the pile, draped down the side a minimum of two inches (2″) and nailed with copper nails. When the first coat of resin has taken a tack free set, a second coat of resin shall be applied to seal the entire application.

PART 4 MEASUREMENT AND PAYMENT

A. The payment for the items specified in the Contract Documents will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Piling (permanent and test) will be measured and paid for at the Contract Unit Price per linear foot for the pertinent Piling item. The measured length of all piling will be taken from its tip up to final cutoff unless otherwise specified in the Contract Documents. For test piles not utilized as permanent piles, the measurement for cutoff will be at the same elevation as the nearest proposed permanent pile or to actual top of test pile, whichever is lower. Where piling designated as test piles is accepted for use in the permanent structure, measurement will be made as test piles and no additional allowance will be made in other piling items.

C. Furnishing and setup of pile-driving equipment required for driving permanent and test piles will not be measured but the cost will be incidental to the Contract Unit Price for the pertinent Pile item.

D. When an item for setup for driving pile is included in the Contract Documents, the furnishing and setup of pile-driving equipment required for driving permanent and test piles will be measured and paid for at the Contract Unit Price per each for the pertinent setup for driving pile items. The unit price per each setup required for driving each pile for the proposed structure will be used regardless of the distance that the equipment must be moved for each pile setup. A maximum of one (1) setup will be paid per pile location. No additional compensation will be paid for any setup required for re-driving or any additional driving of any pile no matter what reason the particular pile may require re-driving or additional driving.

E. Pile points for steel H piles will be measured and paid for at the Contract Unit Price per each of the pertinent Pile Points for Steel H Pile items.

F. Timber sheet piling will be measured and paid for at the Contract Unit Price per ONE THOUSAND (1000) board feet for the pertinent Timber Sheet Piling item. Computation of quantities will be based on nominal thickness of lumber, the length of the sheet piling, and the average depth of the sheet piling from cutoff at the top to the tip of the sheet piling in the completed structure. No allowance will be made for waste.

G. Steel sheet piling will be measured and paid for at the Contract Unit Price per square foot as measured along the plane of the surface for the pertinent Steel Sheet Piling item.

H. The following will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents:

1. When specified, tips for steel pipe piles.
2. Test pieces of sheet piling (timber or steel).
3. Dewatering, clean out, filler, reinforcement and concrete used in steel pipe piles.
4. Pile splices.
5. Augering, including sleeve and backfill when required.
6. Cleaning, painting, or coating of piling.
7. Piling or sheet piling for temporary structures, piles or sheet piling driven for the Contractor's convenience, or for any piles or sheet piling not specified in the Contract Documents.
8. Piling not approved by the Engineer, such as piles not properly driven, piles with questionable safe bearing values, piles damaged during driving, or piles driven below planned cutoff or the removal of any pile rejected by the Engineer as unsatisfactory.
9. Glass resin composite shield used on timber piles.

31 62 13.21 PROTECTIVE JACKETS FOR PILES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall include cleaning piles, fabricating, furnishing and placing wire fabric, fabricating, furnishing, installing and sealing the protective jackets and filling the void between pile and jacket with grout as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fine Aggregate shall conform to the following:

1. Grading requirements are outlined in the following Tables A, physical properties and in Table B. Force drying may be used in the preparation of samples for grading tests conducted in the field. Steel slag may be used for chip seal surface treatment, but it shall not be used for any other aggregate.

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T27

MATERIAL	SIEVE SIZE									
	3/8 "	No. 4	No. 8	No 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
FINE AGGREGATE — PORTLAND CEMENT CONCRETE, UNDERDRAIN, and PNEUMATIC MORTAR (a)	100	95–100	—	—	45–85	—	—	5–30	0–10	—
FINE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE (a)	100	85–100	—	—	40–80	—	—	10–35	5–25	—
FINE AGGREGATE/SAND MORTAR and EPOXIES (a)	—	100	95–100	—	—	—	—	—	0–25	0–10

Note: (a) Fine aggregate includes natural or manufactured sand.

TABLE B – AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

MATERIAL TYPE I	TEST METHOD					
	SPECIFICATIONS	T 104	T 112	T 11	T 113	T 21
		SODIUM SULFATE SOUNDNESS % max	CLAY LUMPS & FRIABLE PARTICLES % max	MATERIAL FINER THAN No. 200 SIEVE % max	COAL & LIGNITE % max	ORGANIC IMPURITIES Max
FINE AGGREGATE — PCC (a)(b)	M 6 CLASS B	10	3.0	4.0(e)	1.0	3.0
FINE AGGREGATE — LIGHTWEIGHT PCC (c)	M 195	—	2.0	—	—	3.0
FINE AGGREGATE /SAND MORTAR & EPOXIES	M 45	10	1.0	—	0.5	3.0

Note: (a) Coarse and fine aggregate for PCC shall be tested for alkali silica reactivity (ASR) as specified in MSMT 212.

Note: (b) In areas exposed to traffic manufactured sand shall have a minimum ultimate polish value of eight (8), based on the parent rock.

Note: (c) Fine aggregate conforming to M 6 may be used if the lightweight concrete does not exceed the maximum unit weight specified in the Contract Documents.

B. Portland Cement Type II shall conform to M 85, with the fineness and the time of setting determined in conformance with T 153 and T 131, respectively.

C. Concrete Admixture shall conform to the following:

1. Concrete admixtures shall not contribute more than two hundred (200) ppm of chlorides based on the cement content when tested as specified in Maryland

Standard Methods of Tests (MSMT) 610. Only prequalified admixtures shall be used.

2. A pozzolan and Type I (PM) or Type IP cement shall not be used in the same mix. Since the strength gains are delayed with these materials, a longer period of time may be required for curing and form removal.
3. Air Entraining Admixtures. Air entraining admixtures shall conform to M 154.
4. Chemical Admixtures. Chemical admixtures shall conform to M 194, Type A, D, or nonchloride C.
5. High Range Water Reducing Admixtures. High range water reducing admixtures shall be liquid and shall conform to M 194, except that the water content shall be a maximum of eighty-five percent (85%) of that of the control, and the durability factor shall be a minimum of ninety (90). Type F shall be used for early strength and shall produce a minimum compressive strength in twelve (12) hours of one hundred eighty percent (180%) of that of the control. Type G shall be used when early strength is not specified. The manufacturer shall furnish certification as specified in TC-1.02. The certification shall include curves indicating the fluid ounces of admixture per one hundred pounds (100 lb) of cement as related to water reduction and strength gain for twelve (12) hours when used with a minimum cement factor of seven hundred pounds (700 lb).
6. Pozzolans. The Contractor may request the use of pozzolans to control alkali silica reactivity or for other reasons. When a pozzolan is used, the minimum cement factor and water/cement ratio shall be determined on the basis of the combined weight of cement and pozzolan. See the following Table C for percentage of fly ash, ground iron blast furnace slag, and microsilica.

TABLE C

OPTION	ALKALI CONTENT OF CEMENT % max	REPLACE CEMENT WITH		SPECIFICATION
		MATERIAL	% BY WEIGHT	
1	1.50	Class F Fly Ash	15 – 25	M 295
2	1.50	Ground Iron Blast Furnace Slag	25 – 50	M 302 Grade 100 or 120
3	1.50	Microsilica	5 – 7	C 1240
4	—	Blended Cement (a)	100	M 240
5	0.60 (b)	Low Alkali Cement	100	M 85

Note: (a) Pozzolan content of fifteen to twenty five percent (15% – 25%) by weight of cement

Note: (b) For mixes (Mix 6 Modified, twelve (12) Hour Patch Mix) used for portland cement concrete pavement repairs; the maximum allowable percentage of alkalis in portland cement shall be seven tenths (0.70).

a. Fly Ash. Fly ash shall conform to M 295, pozzolan Class C or F, except that the maximum permissible moisture content shall be one percent (1.0%), and when used in concrete Mix Nos. 3 and 6 the loss on ignition shall not exceed three percent (3.0%).
b. Ground Iron Blast Furnace Slag. Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.

c. Microsilica. Microsilica shall conform to C 1240, except that the oversize requirement is waived.

7. Ground Iron Blast Furnace Slag. The Contractor may request to substitute a maximum of fifty percent (50%) of the weight of cement with ground iron blast furnace slag. When ground iron blast furnace slag is used, the minimum cement factor and water/cement ratio will be determined on the basis of the combined weight of the cement and ground iron blast furnace slag. Ground iron blast furnace slag shall conform to M 302, Grade 100 or 120.

8. Synthetic Fibers. When synthetic fibers are specified in the Contract Documents, the fibers shall be one half inch to one and one-half inches (1/2″ to 1-1/2″) long and conform to C 1116, Type III. The manufacturer shall furnish certification as specified in TC-1.02. The quantity of fibers used and their point of introduction into the mix shall conform to the fiber manufacturer's recommendations.

D. Water shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

E. Welded Wire Fabric. Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.4 wire on 3 inch (3″) centers in each direction or from W0.9 wire on two inch (2″) centers in each direction. Galvanized coating for fabric, ties, and connecting wire shall not be less than eight tenths (0.8) oz/ft^2 when tested as specified in A 90.

F. Fiberglass Protective Pile Jackets. Preformed fiberglass shall conform to the following Table D and paragraph 2.2.

TABLE D

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Density, g/cm, min	D 792	1.25
Absorption, % max	D 570	1.0
Tensile Strength, average of five specimens each direction*, psi min	D 638	10000
Thickness (unless otherwise specified), in.	—	3/16
Thickness Tolerance, in.	—	+1/16, −0
Color No.	Fed. Std. 595	26622

* Longitudinal and transverse directions.

G. Anchor/Standoff Devices shall conform to A 185.

H. Stainless Steel Screws shall conform to A 193, Type 303.

2.2 JACKETS

A. The jackets for new piles shall be fabricated in one (1) solid piece with no longitudinal joint. The closure joint on jackets for existing piles need not be self-locking provided the joint can be field formed with fiberglass and is approved by the Engineer. The field formed closure joint shall conform to the tensile strength of the jacket. All jackets shall be a minimum thickness of one-quarter inch (1/4″). The surfaces of the fiberglass shall be free of bond inhibiting agents.

B. Jackets for steel and concrete piles shall be provided with noncorrosive standoffs on the inside face to maintain the jackets in the required positions.

2.3 CLOSURE JOINT WARRANTY

When closure joints are used for existing piles, the manufacturer and Contractor shall both furnish the City a written five-year (5) warranty against manufacturing and installation defects prior to starting the installations.

2.4 GROUT

The Contractor shall submit in writing the proposed grout mix design and method of installation to the Engineer for approval before ordering any material.

2.5 STEEL AND CONCRETE PILES

A. Grout shall consist of a minimum of eight hundred forty-five (845) lb/yd^3 of cement, six (6) plus or minus one percent (± 1%) of air entrainment by volume, and be proportioned with fine aggregate and water to provide a pumpable mixture. The minimum twenty-eight (28) day compressive strength shall be thirty five hundred (3500) psi.

B. Ready mixed grout will be permitted by written permission of the Engineer. The ready mixed grout shall be furnished by a manufacturer approved by the Engineer.

2.6 TIMBER PILES

Grout shall consist of water insensitive epoxy and fine aggregate mixed in conformance with the manufacturer's recommendations.

PART 3 EXECUTION

3.1 GENERAL

Working Drawings showing equipment, installation procedure including location of tremie pipes, injection port, method of sealing the bottom of the jacket and method of support during placement of the grout, shall be prepared by the Contractor and submitted for approval prior to the start of field installations. Jackets shall not be installed until the Engineer approves the procedure and material in writing.

3.2 CLEANING PILES

A. The piles shall be cleaned of all surface contamination such as grease, oil, tar, loose rust, loose coatings, marine organisms, etc. to the satisfaction of the Engineer.

B. Piles shall be water blast cleaned with a nozzle pressure of eight thousand to twenty thousand (8000 to 20000) psi, except that timber piles shall be cleaned with a nozzle pressure of three thousand to three thousand five hundred (3000 to 3500) psi. The piles shall be cleaned a maximum of twenty-four (24) hours prior to the placing the grout. Jackets shall not be placed until the Engineer has approved the cleaning of the piles.

3.3 PREPARATION OF PROTECTIVE JACKETS

A. The inside faces of the jackets shall be cleaned and abrasive blasted to remove any agents which will inhibit attachment of anchor devices and bonding of the grout with the inside faces of the jackets. The Engineer may require these procedures to be redone if they are not acceptable at the time of placement.

B. Protective jackets will be inspected by the Engineer prior to placement. Loose or damaged anchor devices shall be repaired to the satisfaction of the Engineer. Protective jackets deemed unsatisfactory by the Engineer shall be replaced at no additional cost to the City.

C. The space between the pile and the jacket shall be sealed at the bottom. All temporary support devices used to position the protective jackets during installation shall be external and shall be removed before final acceptance.

3.4 FILLING VOID

A. The void between the pile and the protective jacket shall be filled with grout placed by the tremie method using two (2) tremie pipes or by pumping using an injection port located at the bottom of the protective jacket. Depositing by means of bottom dump buckets is prohibited. Tremie pipes shall be equipped with hopper tops.

B. Only approved mixing equipment shall be used in preparation and handling of the grout. All oil and other rust inhibitors shall be removed from the mixing drums, stirring mechanisms and other portions of the equipment in contact with the grout before the mixers are used. All materials shall be accurately measured by volume or weight as they are fed into the mixer. Time of mixing shall not be less than one (1) minute. The continuously agitated grout may be held in the mixer or agitator a maximum of one (1) hour or for one and one-half (1-1/2) hours when the temperature falls below seventy degrees (70°) F.

C. Grout placement shall be made as one (1) continuous operation for each pile. Special care shall be taken in the placement of grout to obtain a satisfactory flow to ensure proper distribution around and bonding to the pile.

D. If emergency interruptions of continuous grout pumping become necessary, the Contractor shall stop the operations and remove the grout and the jacket. The pile shall be thoroughly cleaned as described above, prior to continuing the operation. The pile jacket shall not be reused unless it is removed prior to initial setting of the grout and is approved by the Engineer.

E. All excess grout shall be removed from the outside of the piles and jackets after the jackets are filled.

3.5 PROTECTIVE JACKET INSPECTION

A. The Contractor's operations will be carefully observed during all phases of Construction. In the presence of the Engineer, the Contractor shall remove the first two (2) protective jackets installed to provide visual evidence that the Contractor's operations are obtaining the desired results. The removal shall not begin until the grout has set sufficiently to

maintain its shape when the protective jacket is removed. The Engineer will examine the grout for cavities, honeycombing, and other defects.

1. If the grout is satisfactory upon removal of the protective jacket, the Contractor's operations will be approved. The Contractor shall remove all grout as directed by the Engineer and clean and reinstall a new jacket in conformance with these Specifications. Reuse of the original protective jacket is prohibited.
2. If the grout on only one of the installations is unsatisfactory upon removal of the protective jacket, the third protective jacket installed shall also be removed and inspected. If this inspection is satisfactory, the Contractor's operations will be approved. Protective jackets shall then be reinstalled as specified in 3.5, 1 above.
3. If the grout is unsatisfactory upon removal of the protective jacket on both of the first two (2) piles inspected or on two (2) out of the three (3) piles inspected as specified in 3.5, 2 above, the Contractor shall submit modifications of the operations to the Engineer for approval before continuing. These procedures shall continue until the Contractor's operations are satisfactory.
4. Additional inspections will be performed whenever required by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for fabricating, furnishing and installing protective jackets including welded steel wire fabric, grout, excavation, and all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. Protective jackets will be measured and paid for at the Contract Unit Price per each for the pertinent Protective Jacket for Pile item.

C. Protective jackets will be measured and paid for at the Contract Unit Price per linear foot (depth) for the pertinent Protective Jacket for Pile item.

D. Protective jacket inspections that are satisfactory and accepted by the Engineer will be measured and paid for at the Contract Unit Price per each for the pertinent Protective Jacket Inspection items. Payment will also be full compensation for removal of the jacket, removal of the grout, cleaning, and reinstalling a protective jacket, welded steel wire fabric, and grout.

E. Protective jacket inspections that are unsatisfactory and rejected by the Engineer will not be measured or paid for. The Contractor shall remove the protective jacket, grout, and welded steel wire fabric and clean the existing structure at no additional cost to the City.

31 64 00 CAISSONS

31 64 16 DRILLED SHAFTS (CAISSONS)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing drilled shafts (caissons) as specified in the Contract Documents, or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures) except as modified herein.

B. Concrete Mix No. 4 shall conform to the following table.

TABLE A

PORTLAND CEMENT CONCRETE MIXTURE								
MIX NO.	28 DAY SPECIFIED COMPRESSIVE STRENGTH psi	STANDARD DEVIATION psi	CRITICAL VALUE psi	MIN CEMENT FACTOR b/yd^3	COARSE AGGREGATE SIZE M 43	MAX WATER/ CEMENT RATIO by wt	SLUMP RANGE inches	CONCRETE TEMPERATURE °F
4	3500	525	3600	615	57, 67	0.55	4 – 8	70° ± 20°

Note 1: When concrete is exposed to water exceeding fifteen thousand (15,000) ppm sodium chloride content, Type II cement shall be used. In lieu of Type II cement, Type I cement may be used in combined form with an amount of up to fifty percent (50%) replacement with ground iron blast furnace slag or an amount of up to twenty-five percent (25%) replacement with Class F fly ash. The Contractor shall submit to the Engineer the proposed mix proportions and satisfactory test results in conformance with C 1012 showing a sulfate resistance expansion not exceeding one tenth percent (0.10%) at one hundred eighty (180) days.

Note 2: The temperature of Mix No. 6 when used for other than superstructure Work as defined in TC-1.02 shall be seventy degrees (70°) plus or minus twenty degrees (± 20°) F

Note 3: When synthetic fibers are used, the slump shall not exceed five inches (5″).

Note 4: Nonchloride Type C admixtures may be used when approved by the Engineer.

Note 5: If a high range water reducing admixture Type F or Type G is used, the slump requirement shall be four to eight inches (4″ to 8″).

Note 6: Type A or D admixture shall be added to bridge, box culvert, and retaining wall concrete.

C. Reinforcement Steel shall conform to the following:

1. Certification: The steel manufacturer shall furnish certification for each heat of steel. Certifications shall include a statement that the material was melted and manufactured in the United States except as provided in the federal regulations with regard to the furnishing and coating of iron and steel products. A nationwide waiver for this provision has been granted for pig iron and processed, pelletized, and reduced iron ore.

2. Deformed Reinforcement. Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615 or A 706, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to the following:

a. Fusion Bounded Epoxy Powder Coatings for Steel: The epoxy protective coating shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. For reinforcement steel, the color shall be bright, in order to contrast with the normal color of reinforcement and rust (e.g. orange, red, green, yellow etc. and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the pre-qualified materials list maintained by the Engineer.

3. Plain Reinforcement: Unless otherwise specified, dowel bars and dowel bars used as ties in PCC pavement expansion and Contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated. Epoxy powder shall conform to the aforementioned paragraph 2.1 C 2 a. All dowel bars used for traverse joints shall have maximum pullout strength in conformance with M 254.
4. Stainless Steel Bars: In lieu of epoxy coated plain bars, the Contractor may use stainless steel bars. Deformed bars shall be stainless steel when specified in the Contract Documents. Stainless steel shall conform to A 276, Type SM-29. Deformed stainless steel bars shall conform to A 615 for cross sectional area and deformations.
5. Sleeves for Dowel Bars in Pavement Expansion Joints. Sleeves for dowel bars shall be of sheet metal capable of sliding over two inches (2″) plus or minus one-quarter inch (± 1/4″) of the dowel and shall have a closed end with a stop to hold the end of the sleeve at a minimum distance of one inch (1″) from the end of the dowel bar.
6. Welded Steel Wire Fabric. Welded steel wire fabric shall conform to M 55. Fabric used in pavement Construction shall be furnished in flat sheets.
7. Welded Deformed Steel Wire Fabric. Welded deformed steel wire fabric shall conform to M 221.
8. Fabricated Steel Bar Mats. Fabricated steel bar mats shall consist of steel conforming to A 184.
9. Wire Fabric for Pneumatically Applied Mortar. Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.4 wire on three inch (3″) centers in each direction or from W0.9 wire on two inch (2″) centers in each direction. It shall be galvanized as specified in the following:

    a. Galvanized Coating for Gabions. Galvanized coating for fabric, ties, and connecting wire shall not be less eight tenths (0.8) oz/ft^2 when tested as specified in A 90.

10. Cold Drawn Steel Wire. Cold drawn steel wire for concrete reinforcement shall conform to M 32.
11. Tie Devices for Concrete Pavement. Tie device sizes shall be as specified in the Contract Documents and produce a frictional force of at least one hundred sixty (160) lb/ft per foot of spacing when tested as specified in MSMT 512.
12. Steel Strand. Steel strand shall conform to M 203, Grade 270, Low Relaxation Strand.

D. Steel Casings shall conform to A 252, Grade 2 or A 36.

PART 3 EXECUTION

3.1 GENERAL

Construction shall conform to 31 23 16.16, Part 3, (Structure Excavation), 02 32 13, Part 3, (Subsurface Drilling and Sampling), and 03 30 00, Part 3, (Portland Cement Concrete Structures), except as modified herein.

3.2 SUBFOUNDATION INVESTIGATION

When the Contract includes an item for Subfoundation Investigation, the Contractor shall conduct a subfoundation investigation program prior to ordering or fabricating reinforcement for drilled shafts. This program shall be used to determine the elevation of suitable bearing stratum and the required depth of the drilled shafts. Test holes shall be drilled at approximately a third of the drilled shaft locations, as selected by the Contractor, spread over the number of shaft locations. Test holes shall be drilled a minimum of ten feet (10') below the estimated drilled shaft length unless otherwise directed by the Engineer. After drilling the test holes, the data obtained will be evaluated by the Engineer to determine the uniformity/variability of the foundation materials. If the evaluation determines that more test holes are required, additional test holes shall be drilled at locations approved by the Engineer.

3.3 SHAFT INSTALLER

A. The Contractor shall obtain the services of a shaft installer having a proven record of experience, having successfully completed not less than three (3) projects with similar subsurface conditions, shaft sizes, depths and minimum volumes of Work as contained in the project. The Contractor shall submit evidence of pertinent experience to the Engineer for approval before proceeding with drilled shaft Work.

B. The Contractor shall furnish a Certified Drilled Shaft report for each drilled shaft. The report shall record the following:

1. Top and bottom elevations.
2. Final center line location at top.
3. Variation of shaft from plumb.
4. Results of tests performed.
5. Levelness of bottom.
6. Seepage of water.
7. Top and bottom elevation of any casings left in place.
8. Any unusual conditions.
9. Variation of dimensions from planned.
10. Dates of start and completion of excavation.
11. Inspection, testing, and placement of concrete (including any delays in concreting and location of Construction joints in shafts).
12. Reinforcement steel.
13. Any additional information relevant to the as-built drilled installation.

C. The Contractor shall record and maintain information pertinent to each drilled shaft and shall provide required data to other testing and inspection personnel.

D. The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection and testing procedures.

3.4 GEOTECHNICAL ENGINEER

A. When specified in the Contract Documents, the Contractor shall employ the services of a qualified geotechnical engineer for inspection and testing for installation of drilled shafts. The geotechnical engineer shall be a professional engineer registered in the State of Maryland, have a demonstrated record of experience with similar drilled installations, and shall be approved by the Engineer prior to beginning augering for the drilled shafts.

B. The geotechnical engineer shall submit a plan containing the proposed methods to be used to inspect the drilled shafts in conformance with this Specification.

C. The geotechnical engineer shall visually inspect the bottom of each drilled shaft and perform tests as necessary to verify the bearing capacity. Drilled shafts shall be founded in material having a minimum design bearing capacity specified in the Contract Documents. The geotechnical engineer shall provide certification that the drilled shafts were properly drilled to a satisfactory depth and bearing.

3.5 HOLES

A. Holes for drilled shafts shall be excavated by auguring, drilling, or hand excavation as necessary to reach the required bearing strata. Casings or slurry shall be installed as excavation proceeds when earth walls cannot be maintained without spilling into the shaft. Casings shall be full-length, watertight, of sufficient thickness to withstand compressive, displacement and withdrawal stresses, and to maintain the shaft walls. Casings shall be withdrawn as concrete is placed, unless otherwise specified in the Contract Documents, or directed by the Engineer.

B. The final bottom elevation of drilled shafts shall be determined by the geotechnical engineer when the services are required. All holes shall be approved by the Engineer.

C. Holes for successive drilled shafts shall not be excavated until adjacent holes are filled with concrete and allowed to set.

D. Drilled shafts shall be constructed within the following tolerances:

1. Maximum permissible variation of center line locations shall not be more than one twenty-fourth (1/24th) of the shaft diameter or three inches (3″), whichever is less.
2. Shafts shall not be out of plumb by more than one and five-tenths percent (1.5%) of the depth, twelve and five-tenths percent (12.5%) of the shaft diameter, or fifteen inches (15″), whichever is less.
3. The top of the shaft or concrete cut-off elevation shall be within one inch (1″) of the design elevation.

E. If the specified tolerances are exceeded, corrective Construction shall be provided to compensate for excessive eccentricity at no additional cost to the City. Proposed methods of corrective Construction shall be submitted to the Engineer for approval before proceeding.

F. The bottom of drilled shafts shall be excavated to an undisturbed, level plane. All loose material shall be removed prior to placing concrete.

G. Drilled shafts shall be dewatered as required to facilitate excavation, inspection and concreting.

H. Each drilled shaft shall be inspected before placing concrete.

3.6 REINFORCEMENT STEEL

A. Reinforcement steel cages for each drilled shaft shall be fabricated and erected as one (1) continuous unit. Reinforcement shall be placed accurately and symmetrically about the axis of the hole, and held securely in position during concrete placement.

B. Exposed ends of extended reinforcement shall be protected from damage.

3.7 CONCRETE

A. Drilled shafts shall be filled with concrete immediately after inspection and approval by the geotechnical engineer and the Engineer.

B. Concrete shall be placed in one (1) continuous operation, in a smooth flow without segregating. Mechanical vibration for consolidation shall be provided for at least the top twenty-five feet (25′) of each shaft. Concrete may be free dropped up to twenty-five feet (25′) provided the Contractor's procedures ensure that the concrete falls vertically without hitting the inside walls of the hole or falling directly on the reinforcement steel. When the Engineer determines that the concrete placement procedures are unsatisfactory, concrete shall be placed by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, tremie, or pumping. Chutes, tremies or pumping shall be used where a drop of more than twenty-five feet (25′) is required.

C. Concrete shall be placed in the dry insofar as practicable. If excessive water occurs and it is not feasible to de-water the drilled pier shaft for concreting, then concrete shall be placed by the tremie method in conformance with 03 30 00, Part 3, (Portland Cement Concrete Structures). Tremie placement operations shall be controlled to ensure that tremie is not broken during continuous placing from bottom to top. Other methods of depositing concrete underwater may be used if approved by the Engineer.

D. A sufficient head of concrete shall be maintained to prevent any reduction in the diameter of the drilled pier shaft by earth pressure and to prevent extraneous material from mixing with the concrete. The withdrawal of temporary casings shall be coordinated with concrete placement operations to maintain a head of concrete approximately five feet (5′) above the casing bottom.

E. Concrete placement shall be stopped at the top cut-off elevations as shown on the Contract Documents. The tops of drilled shafts shall be screeded level and given a roughened surface finish. Where the cut-off elevation is above ground elevation, the top section shall be formed to extend the shaft to the required elevation.

F. Construction joints will be permitted in drilled shafts if concrete placement operations must be interrupted, as accepted by the Engineer. The surface of any Construction joint shall

be screeded level and given a roughened surface. An approved bonding compound shall be applied to the Construction joint surface prior to placing additional concrete.

G. The Engineer may require full-depth continuous coring of drilled concrete shafts where observations of temporary casing removal and concrete placement operations indicate cause for suspicion of quality of concrete, presence of voids, segregation or other defects. This Work shall be performed at no additional cost to the City.

3.8 DEFECTIVE DRILLED SHAFTS

Drilled shafts found to be defective shall be repaired or replaced as directed by the Engineer at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment for the items specified in the Contract Documents will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Drilled shafts including furnishing and setup of augering equipment, augering, drilling, excavating, dewatering, inspection, testing, services of the shaft installer and geotechnical engineer, sleeves, reinforcement, concrete, disposal of excess and unsuitable material, etc., will be measured and paid for at the Contract Unit Price per linear foot for the pertinent Drilled Shaft item.

C. When subfoundation investigation is specified, it will be measured and paid for in conformance with the following:

1. Subfoundation Investigation will be measured and paid for at the Contract Unit Price per linear foot for the actual total length of holes drilled. The payment will be full compensation for the geologist or geotechnical engineer services, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work

31 66 00 SPECIAL FOUNDATIONS

31 66 16.23 CONCRETE CRIBBING FOUNDATION WALLS

PART 1 GENERAL

1.1 DESCRIPTION

This specification is intended to describe a supporting device known as concrete cribbing, also known as crib Work, crib walls and bin type crib Work. It shall consist of precast concrete members, rectangular in section and reinforced with steel bars. These sections are laid on a prepared foundation in tiers or levels. Generally, the assembled unit has a bevel or batter so as to lean towards the embankment for which it is intended to support. After erection, the space within the concrete members is backfilled. The cribbing or crib walls shall be precast, delivered, erected, backfilled and tamped in accordance with the Plans, Special Provisions or described in the manufacturer's catalog.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete crib wall sections shall be rectangular in section and of lengths shown or described.

B. The sections shall be reinforced with reinforcing steel conforming to A615, Grade 60.

C. All concrete for crib wall shall be Mix No. 3, thirty five hundred (3500) psi.

D. As a general rule, concrete cribbing is purchased from manufacturers or producers making a specialty of this line of Work. If the sections are so procured, the Engineer will accept the members as manufactured and delivered if in sound condition and free from any damage. The Engineer however, reserves the right to investigate the methods of manufacture, as well as make compression tests on pieces delivered. No cribbing members will be accepted where in the strength of the concrete is found to be less than thirty-five hundred (3500) psi.

E. If cribbing sections are not obtained from manufacturers specializing in this Work, they shall be precast of Mix No. 3, thirty-five hundred (3500) psi concrete, using plywood or steel forms and all mixing, proportioning, curing, protecting against weather and other processes described in 03 30 00 for concrete Work and concrete mixtures will apply.

F. Backfill for filling in the spaces between the crib walls shall be acceptable embankment material such as gravel, crushed stones or other granular material approved by the Engineer or as specified for the project.

PART 3 EXECUTION

3.1 GENERAL

A. Concrete cribbing sections are usually separated into two (2) types of members known as headers and stretchers. The foundation shall be prepared, the crib sections erected and the spaces backfilled in accordance with the following general requirements.

1. Excavation shall be such as to prepare by trenching a firm foundation for the bottom members, which are usually stretchers. A firm foundation shall be obtained well below the frost line and any danger of scour, unless otherwise shown on the Plans or directed by the Engineer.
2. The front and rear trenches shall be placed at different elevations so that the wall, in completed position, will be battered or beveled so as to lean in the direction of the embankment to be supported.
3. Alternate courses of headers and stretchers shall then be installed at right angles to each other.
4. The manufactured and delivered or cast-on-the-job cribbing members shall be constructed with notches or offsets so as to lock the headers and stretchers in their erected positions.
5. Where closed faced type of cribbing is specified, additional stretchers are supplied to fill the horizontal openings on the front space or the stretchers are especially cast with additional depth of course.
6. Backfills shall progress simultaneously with the erection of the cribbing.

7. In placing backfill, care shall be exercised that mechanical equipment used does not strike and damage the concrete-cribbing members.
8. The backfill material shall be placed in eight inch (8″) layers and tamped or otherwise consolidated to the satisfaction of the Engineer.

B. All exposed corners of crib wall units shall be chamfered one-half inch by one-half inch (1/2″ X 1/2″). The exception is, do not chamfer ends of all stretchers.

C. These wall sections are based upon reaching satisfactory bearing with a minimum of excavation. However, should the Engineer direct the wall start at a lower elevation than planned, then the height of the wall may cause the section to change from A to B, B to C or C to D.

D. All "TOP OF WALL ELEVATIONS" and "TOE OF WALL ELEVATIONS" are level.

E. All bearing blocks are five and three-quarters inches (5-3/4″) thick set in mortar.

F. When rock is encountered, rock shall be removed to one foot (1′) minimum depth below the bottom of cribs as necessary for leveling and bearing members (stretchers).

G. Leveling and Bearing members (stretchers) are to be set in one to three (1:3) mortar at the time wall is erected.

H. The stretchers shall match the Crib Wall type either close face or open face.

I. The wall shall be separated into sections every ninety feet plus or minus (90′±) by provision of double rows of headers.

PART 4 MEASUREMENT AND PAYMENT

A. Crib walls will not usually be measured, as they will be classified on lump sum basis. Drawings will provide heights, lengths and depths of the various sections, as well as batters and bevels, or reference will be made to manufacturer's catalog, types and standard details of Construction.

B. In event, however that it should be desired to obtain Bids on types of cribbing or crib walls likely to vary, unit price items may be set forth in the Proposal and in which case the measurement will be on the front area basis in square yards. Dimensions will be taken parallel to and at the front face of the wall vertically and horizontally for each section. The product of these dimensions will be the pay area for the section. The pay area for the entire installation will be the sum of the front areas of all the sections.

C. Concrete cribbing satisfactorily completed and accepted and counted on the lump sum basis or measured as described in the preceding section will be paid for at the pertinent Contract lump sum or unit price, as may be called for by the Proposal, which price shall include all materials, concrete sections, reinforcing, manufacture or precasting and delivery, excavation, preparing foundation, handling, erection, backfilling, tamping and all equipment, tools, labor and incidental Work.

DIVISION 32
EXTERIOR IMPROVEMENT

32 01 00 OPERATION AND MAINTENANCE OF EXTERIOR IMPROVEMENTS

32 01 13.61 SLURRY SEAL

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing a slurry seal course using a slurry seal (SS), or latex modified slurry seal (LMSS) as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mineral Filler: Mineral filler shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Water: Water shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

C. Aggregate: Aggregates shall be crushed stone, compatible with the emulsion and shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

D. Emulsified Asphalt: Emulsified asphalt shall conform to M 208, Grade CSS-1h, except that the cement mixing test is waived. Emulsified asphalt shall not separate before placement of SS or LMSS.

E. Latex Modified Emulsion: The latex modifier and other emulsifiers shall be milled into the asphalt cement. The emulsified asphalt shall be modified by the addition of three (3.0) plus or minus four-tenths percent (± 0.4%) latex solids by weight of the asphalt. The latex modifier shall be an unvulcanized styrene butadiene rubber (SBR) or one hundred percent (100%) natural latex in liquid form. The manufacturer shall furnish certification showing actual test results in conformance with these Specifications. This certification shall be a document, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

F. Mix Design Approval: Mix design data shall be submitted to the Engineer for approval at least three (3) weeks in advance of the paving operation. The mix design shall list the ingredients and their proportions as well as the gradation of the proposed aggregate.

G. The SBR latex modifier shall conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Styrene Butadiene Ratio	24:76 ± 1.5
Solids Content, % min	60
pH, max	6.2
Weight Per Gallon, Wet Basis @ 25° C, lb min Dry Basis @ 25° C, lb min	 7.9 4.5

H. Latex modified emulsion CSS-1h shall conform to M 208 modified as follows:

1. The one hundred percent (100%) natural latex shall be an high ammonia natural latex conforming to D 1076, Type I.

I. The mix design report shall show test results conforming to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Maryland Standard Method of Tests 403, Mixing Test, minutes min	2
Maryland Standard Method of Tests 403, Setting Time, minutes max	30
Maryland Standard Method of Tests 403, Water Resistance	Slight Discoloration
Maryland Standard Method of Tests 403, Wet Track Abrasion, g/ft^2 max	75
International Slurry Seal Association (ISSA) TB 139, Set Time Test, 30 minutes, kg/cm min	12

J. The percent of residual asphalt, based on the dry aggregate weight, shall be between eight (8.0) and twelve and five-tenths (12.5) for Type II Mix and seven (7.0) and eleven (11.0) for Type III Mix, each having a control tolerance of plus or minus one percent (± 1.0).

K. The Contractor shall submit sufficient material for testing the mix design whenever corroborating information is required by the Engineer.

RESIDUE REQUIREMENTS	
TEST PROPERTY	**SPECIFICATION LIMITS**
Penetration @ 25° C, min	30
Ductility @ 25° C, min @ 4° C, min	150 100
R and B Softening Point, °F, min	140
Cement Mixing Test	Waived

L. The latex modified emulsion, after standing undisturbed for twenty-four (24) hours, shall be a uniform color throughout.

M. Mix Design. The mix design shall conform to the following:

N. The stability shall be a minimum of eighteen hundred (1800) lb and the flow shall be six hundredths to sixteen-hundredths inches (0.06″ to 0.16″) when tested as specified in T 245, Modified (modification permits air drying of the mixture at seventy degrees to seventy-five degrees (70° to 75°) F for a minimum of twenty-four (24) hours, followed by placement in a one-hundred forty degree (140°) F oven and drying to a constant weight prior to reheating and placing in molds).

PART 3 EXECUTION

3.1 WEATHER RESTRICTIONS

A. The slurry seal shall only be placed when the air and surface temperatures are a minimum of fifty degrees (50°) F, when it is not raining, and when the local weather forecast does not predict precipitation or the temperature to fall below forty degrees (40°) F within twenty-four (24) hours from the time the mixture is placed.

B. When the surface or air temperature falls below the specified limits, placement of the mix shall cease. Material en route may be placed at the Contractor's risk.

3.2 MIXING EQUIPMENT

A. Slurry seal shall be produced in a self-propelled, front feed, continuous loading-mixing machine. The unit shall proportion and deliver the materials to a revolving, multiblade, shafted mixer and discharge it continuously and uniformly.

B. The mixer shall have devices that control the proportioning of each material at all times. The mixer shall be calibrated for the mix design in the presence of a City representative, or certified calibration documents may be accepted by the Engineer. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, additives, and water to maintain an adequate supply of the materials for the proportioning controls.

C. Mixing machines shall be equipped with water pressure systems and nozzle spray bars to provide a water spray ahead of and outside the spreader box when required. Mineral filler shall be added to the aggregate in the proper amount before introduction into the mixer.

D. Truck mounted machines with positive, nonslipping aggregate delivery systems, but without a front feed continuous loading feature, may be used on project segments of less than fifteen thousand (15,000) yd^2 or for spot repair projects.

E. When truck-mixing machines are used, a minimum of two (2) shall be on the project prior to Construction.

3.3 SPREADING EQUIPMENT

Slurry seal shall be spread uniformly by means of a mechanical squeegee box attached to the mixer and equipped with paddles mounted on an adjustable shaft to continuously agitate and distribute the materials. The equipment shall provide sufficient turbulence to prevent the mix from setting in the box or causing excessive side buildup or lumps. The Contractor shall attach flexible seals to the box in contact with the road, front and rear, to prevent loss of the mixture. Spraying of additional water into the spreader box is prohibited.

3.4 SURFACE PREPARATION

A. The surface shall be clean, dry and free of all objectionable materials prior to applying the tack coat and slurry seal.

B. A tack coat consisting of one (1) part asphalt emulsion to three (3) parts water shall be applied to all surfaces unless otherwise directed by the Engineer. The tack coat shall be the same emulsion type and grade as used in the slurry seal. The application rate shall be five-hundredths to one-tenth (0.05 to 0.10) gal/yd^2 or as determined by the Engineer.

3.5 APPLICATION

A. Slurry seal shall be spread to repair slight irregularities and achieve a uniform, skid resistant surface without skips, lumps or tears, as determined by the Engineer.

B. The Contractor shall use squeegees and lutes to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading.

C. When hand spreading is necessary, additives may be used to provide slower setting time. The SS and LMSS shall be poured in a small windrow along one edge of the surface to be covered and then spread uniformly. A smooth, neat seam shall be constructed where two (2) passes meet. Excess material shall be removed immediately from the ends of each run.

1. Slurry Seal: The SS shall be applied at the rate of sixteen (16) plus or minus two (± 2) lb/yd^2 for Type II Mix and twenty (20) plus or minus two (± 2) lb/yd^2 for Type III Mix, based on the dry aggregate weight, unless otherwise specified in the Contract Documents.
2. Latex Modified Slurry Seal: The LMSS shall be applied in one or two (1 or 2) lifts as directed by the Engineer.

    a. For roadways specified to receive one (1) application, the LMSS shall be applied at the rate of sixteen (16) plus or minus two (± 2) lb/yd^2 for Type II Mix and twenty two (22) plus or minus two (± 2) lb/yd^2 for Type III Mix, based on the dry aggregate weight, unless otherwise specified in the Contract Documents.
    b. When two (2) applications are specified, the material shall be applied at the combined rate of twenty-eight (28) plus or minus two (± 2) lb/yd^2 for Type II Mix and thirty-two (32) plus or minus two (± 2) lb/yd^2 for Type III Mix.

3.6 CERTIFICATION

Certified weight tickets shall be furnished to the Engineer for the emulsion, latex emulsion, aggregate, and mineral filler used to ensure specified application rates.

3.7 SAMPLING AND TESTING

The Contractor shall sample the mixtures at least once daily during paving. Each sample shall be placed in a one (1) gallon container. Samples shall be submitted to the Engineer for testing. Residual asphalt content, gradation, stability and flow shall be determined for SS and LMSS in conformance with T 30, T 164 and T 245, Modified.

3.8 TIE-INS FOR ENTRANCES AND CONNECTING ROADS

Tie-ins shall be made at entrances and connecting roads as directed by the Engineer.

3.9 TRAFFIC

SS and LMSS shall be capable of curing at rates that will permit traffic on the pavement within two (2) hours and one (1) hour, respectively after application, without damaging the surface. Any damage to the SS or LMSS caused by traffic shall be repaired by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. Slurry Seal and Latex Modified Slurry Seal will be measured and paid for at the Contract Unit Price per square yard for one or more of the pertinent items below. The payment will be full compensation for furnishing and placing the aggregate, tack coat, tie-ins to entrances and connecting roads, mineral filler, emulsion, latex emulsion and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Slurry Seal Using Type II Mix (One (1) Coat).

C. Slurry Seal Using Type III Mix (One (1) Coat).

D. Latex Modified Slurry Seal Using Type II Mix (One (1) Coat).

E. Latex Modified Slurry Seal Using Type III Mix (One (1) Coat).

F. Latex Modified Slurry Seal Using Type II Mix (First Coat).

G. Latex Modified Slurry Seal Using Type III Mix (Second Coat).

H. Price Adjustment. Material not conforming to these Specifications may be accepted at a reduced price if the Engineer determines that it is not detrimental to the Work. The following price adjustment will apply:

1. The residual asphalt content of samples will be averaged for each day's production per lift and will be compared to the mix design submitted by the Contractor. A one percent (1%) reduction in Contract Unit Price per square yard will be applied for each one tenth percent (0.10%) the asphalt content is out of tolerance.
2. The Contract Unit Price per square yard will be reduced five-tenths percent (0.5%) for each gram per square foot of Wet Track Abrasion Test loss between seventy-five (75) and one hundred (100) grams in conformance with Maryland Standard Method of Tests 403. Material having a loss greater than one hundred (100) grams will be rejected.
3. For applications less than the specified rate, the Contract Unit Price per square yard will be reduced three percent (3%) for each pound per square yard below the specified rate. This adjustment will be determined by comparing the certified delivery tickets with the project Specifications. Material applied at more than the specified rate will not be considered for payment.

32 01 16.71 GRINDING HOT MIX ASPHALT PAVEMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of grinding the hot mix asphalt (HMA) pavement to the depth and at the locations specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Hot Mix Asphalt (HMA). Hot mix asphalt shall conform to 32 12 16.13, (Plant Mix Asphalt Pavement).

PART 3 EXECUTION

3.1 GENERAL

Roadway patching shall be performed before the grinding operation. Additional roadway patching may be required to correct pavement defects made visible by the grinding operation. Refer to 32 01 17.59, (Hot Mix Asphalt Patches) for HMA Patches.

3.2 EQUIPMENT

A. The grinding equipment shall have a cutting mandrel with carbide tipped cutting teeth and shall be designed specifically for grinding asphalt surfaces to close tolerances. The equipment shall accurately establish slope elevations and profile grade controls.

B. A vacuum equipped street sweeper, capable of removing all loose material from the roadway without causing dust to escape into the air, shall follow immediately behind the grinding machine.

3.3 CONTROL STRIP

A. The Contractor shall grind a control strip. The strip shall be five hundred feet (500′) minimum in length with a uniformly textured surface and cross section as approved by the Engineer.

B. The final pavement surface shall have a transverse pattern of two-tenths inch (0.2″) center to center of each strike area. The difference between the high and low of the matted surface shall not exceed one-sixteenth inch (1/16″).

3.4 PAVEMENT GRINDING

A. The designated area shall be ground using the same procedures, settings, and speed, and conform to the same requirements as those used in the control strip.

B. When necessary, the existing pavement adjacent to the ground pavement areas shall be ground, to maintain an adequate cross slope for drainage. Grinding will not be required on bridge decks.

C. The grinding operation shall be performed in only one (1) lane at a time. When grinding highways carrying traffic, all grinding exceeding two and one-half inches (2-1/2″) shall have the abutting lane or shoulder ground on the same day. When grinding to a depth of two and one-half inches (2-1/2″) or less, the Contractor has the option of grinding the abutting lane or shoulder on alternate days. The abutting lane or shoulder shall be ground regardless of depth prior to weekends and temporary shutdowns. Where uneven pavement joints exist, the Contractor shall provide adequate advance warning traffic control devices in conformance with the Contract Documents.

D. Temporary pavement tie-ins shall be constructed a minimum of four feet (4′) in length for each one inch (1″) of grinding depth.

E. After the grinding operation, the pavement surface shall be tested transversely and longitudinally with a ten feet (10′) straightedge furnished by the Contractor. The difference between the bottom of the straightedge and the matted surface shall not exceed one-eighth inch (1/8″). All areas with high spots greater than one-eighth inch (1/8″) within ten feet (10′) shall be corrected by additional grinding at no additional cost to the City. "Straight edge" requirements apply to areas across joints and repaired cracks but are not applicable to areas outside the ground area.

F. After the grinding operation is complete, all depressions, potholes, and other irregularities shall be filled and any existing manholes, valve boxes, inlets, or other structures shall be wedged using HMA conforming to 32 12 16.13, (Plant Mix Asphalt Pavement).

PART 4 MEASUREMENT AND PAYMENT

A. Grinding Hot Mix Asphalt Pavement with carbide cutting bits will be measured and paid for at the pertinent Contract Unit Price per square yard. The square yard measurement will be computed from the actual width and length measurements of the area that has been ground. The payment will be full compensation for grinding, removal and disposal of ground material, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Filling depressions and potholes, and wedging manholes, valve boxes, inlets, or other structures using hot mix asphalt will be measured and paid for as specified in the Contract Documents.

C. Hot Mix Asphalt Patches will be measured and paid for as specified in 32 01 17.59, Part 4, (Hot Mix Asphalt Patches).

32 01 17.59 HOT MIX ASPHALT PATCHES

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of repairing rigid, flexible, or composite pavements by removing part or all of the section of the existing pavement and replacing the removed materials using hot mix asphalt (HMA) paving material. The locations of the repairs will be as specified in the Contract Documents or as directed by the Engineer.

B. Partial Depth Patching (PDP). PDP shall consist of the removal of areas of unsound pavement material, up to a fifty percent (50%) maximum of the pavement thickness in depth, and replace with HMA as specified in the Contract Documents or as directed by the Engineer. The pavement thickness is defined as the thickness of all bound materials in the pavement structure including HMA, portland cement concrete (PCC), and any other asphalt or cement modified materials.

C. Full Depth Patching (FDP). FDP shall consist of the removal of specified areas of the full thickness of the pavement sections to the top of the aggregate base material and replace with HMA as specified in the Contract Documents or as directed by the Engineer. FDP shall be used whenever the fifty percent (50%) maximum pavement thickness for PDP has to be exceeded.

PART 2 PRODUCTS

2.1 MATERIALS

A. Graded Aggregate Base: Graded aggregate base shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Aggregates for HMA: Aggregates for HMA shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

C. Aggregates for Superpave Mixes: Aggregates for superpave mixes shall conform to MP2 and 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

D. Performance Graded Asphalt Binders and Hot Mix Asphalt: Performance graded asphalt binders and hot mix asphalt shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

E. Crack Filler: Crack filler shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

F. Production Plant: Production plant shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

PART 3 EXECUTION

3.1 GENERAL

The existing pavement shall be removed with a minimum disturbance to the base material and the faces of the remaining pavement shall be plane, without ragged edges. The use of equipment that could damage the existing pavement is prohibited.

3.2 WEATHER RESTRICTIONS

Refer to 32 12 16.13, (Plant Mix Asphalt Pavement).

3.3 EXISTING PAVEMENT

A. Each day the Contractor shall complete all repairs for which excavation has been completed. Open excavated areas at the end of the workday are prohibited.

B. Removal of Pavement for PDP. For PDP the existing pavement shall be removed by milling, grinding, or saw cutting and removal to the specified depth for the full perimeter of the designated area. Where concrete is encountered prior to reaching the specified depth, the depth of the patch shall then be limited to the top elevation of the PCC. Prior to application of the patch, the bottom of the excavation of all PDP shall be inspected and cleaned of all loose and foreign materials. For PDP of composite pavements, the PCC shall not be damaged during removal of the existing HMA and all spalled cracks and joints shall be tack coated, filled, and tamped with HMA before the patch is to be placed. When the material at the bottom of the PDP is determined to be unsuitable and not structurally adequate, additional material shall be removed until sound material is encountered. When PCC is encountered in a composite pavement and determined to be unsuitable, the removal and replacement of the patch shall follow the description and Specification of a FDP.

C. Removal of Pavement for FDP. For FDP the existing pavement shall be removed by making a perpendicular saw cut full depth for the full perimeter of the designated area. The repair shall be excavated to the top of the aggregate base material. Refer to the applicable portions of 32 01 29.64, (Repairing Portland Cement Concrete Pavement) Part 3 for the concrete portion of a composite pavement. The boundaries of the patch shall have square vertical faces after saw cutting.

3.4 BASE AND SUBGRADE PREPARATION

A. The Engineer will evaluate the aggregate base of the FDP area to determine if it is suitable as a foundation for the repair. When the Engineer determines that the aggregate base material is not stable, it shall be compacted as specified in 32 11 23.10, Part 3.2, (Aggregate Base Course) to the satisfaction of the Engineer. When no aggregate base is present under the pavement, the subgrade foundation shall be constructed as specified in 31 23 13, (Subgrade Preparation) and as directed by the Engineer. When the Engineer determines that the aggregate base or subgrade material is unsuitable, the material shall be replaced with graded aggregate base conforming to 32 11 23.10, Part 2, (Aggregate Base Course). This operation is defined as removal and replacement of unsuitable material. The replacement aggregate material shall be compacted in layers of four inches (4″) maximum depth. The existing pavement materials that are removed shall be disposed of immediately by the Contractor.

B. The Contractor shall protect the aggregate base or subgrade after preparation. No payment will be made for removal and replacement of subgrade that was not protected.

3.5 SUBGRADE DRAINS

The Engineer may direct that subgrade drains be constructed in areas of wet underlying subgrade or areas where there may be a future drainage problem as determined by the Engineer.

3.6 EMERGENCY FILLER

The Contractor shall have readily available sufficient cold patch material to completely fill the void of the repair area. This material shall be subject to the approval of the Engineer and shall be placed and compacted in the void when directed by the Engineer. At the beginning of the next day's Work, this material shall be completely removed as directed by the Engineer.

3.7 STEEL PLATES

The Contractor shall have an ample supply of twelve feet by fourteen feet by one inch (12′ X 14′ X 1″) thick steel plates available on the project to cover the emergency filler. The Contractor shall complete the City Steel Plate Installation form and fax it to the Steel Plate Inspection Section at 410-396-1967 prior to installing any steel plates.

3.8 PATCH CONSTRUCTION

Patch Construction shall conform to the applicable portions of 32 12 16.13, (Plant Mix Asphalt Pavement). Manual operation will be permitted for placement of the HMA. Cores, control strip, and pavement profile measurements are waived. Equipment, placement, compaction, and quality control procedures shall be as approved by the Engineer.

3.9 PATCH PLACEMENT

A. Prior to placing the HMA, the exposed vertical surface of all adjacent pavements shall be thoroughly cleaned and all vertical surfaces shall be tack coated in conformance with 32 12 16.13, Part 3, (Plant Mix Asphalt Pavement). The HMA mixture may be spread by shovel, rake or other method approved by the Engineer. Placing HMA on a frozen base is prohibited.

B. Minimum and maximum lift thickness for HMA Superpave mixes shall be maintained during patching in conformance with the following:

TABLE F – HMA SUPERPAVE LIFT THICKNESS

MIX DESIGNATION (mm)	MINIMUM (inches)	MAXIMUM (inches)
9.5	1.0	2.0
12.5	1.5	2.5
19.0	2.0	3.0
25.0	3.0	4.0
37.5	4.0	5.0

3.10 TESTING AND ACCEPTANCE

A. Acceptance shall be determined by nuclear in place density test data and witnessed by the Engineer. The nuclear gauge shall be calibrated in conformance with Maryland Standard Method of Tests 417 except that only five (5) randomly selected locations shall be chosen in the first patch. The Contractor shall take one (1), one (1) minute special calibration nuclear test from each lift of each patch. Test locations shall be randomly selected from within the patch. A special calibration nuclear test is defined as an average of two (2) (minimum) special calibration readings taken at the same location after rotating the nuclear gauge one-hundred eighty degrees (180°).

B. Nuclear in place density test data shall be expressed as a percentage of the maximum specific gravity determined for each day's production. The in place density of each patch shall be ninety-two percent to ninety-seven percent (92.0% to 97.0%).

C. The results of all nuclear density tests from each patch shall be averaged and compliance will be determined on the basis of each patch tested.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for saw cutting, milling, grinding, removal, disposal, trimming of the existing pavement, subgrade preparation, placing all materials including tack coat, steel plates, emergency filler, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. All steel plates and emergency filler after removal shall remain the property of the Contractor.

C. Partial Depth Patching and Full Depth Patching will be measured and paid for at the Contract Unit Price per square yard or per ton as specified in the Contract Documents. The payment will be full compensation for furnishing, hauling, placing all material, additional removal of pavement above the aggregate base, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

D. Removal of unsuitable material and refill will be measured and paid for at the Contract Unit Price per cubic yard. The payment will also include excavation and disposal of unsuitable material, backfilling with aggregate, and compaction.

32 01 17.61 SEALING CRACKS IN ASPHALT PAVING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of cleaning and filling cracks one-eighth inch to one and three-quarter inches (1/8″ to 1-3/4″) wide in hot mix asphalt (HMA) pavement as specified in the Contract Documents or as directed by the Engineer. Cracks less than one-eighth inch (1/8″) wide shall not be filled. Distressed areas shall be repaired as specified herein and as directed by the Engineer. Cracks more than one and three-quarters inches (1-3/4″) wide and map, edge or alligator cracks requiring major repairs are not included in this Specification; refer to 32 01 17.59, (Hot Mix Asphalt Patches).

PART 2 PRODUCTS

2.1 MATERIALS

A. Performance Graded Asphalt Binders and Hot Mix Asphalt (HMA). Performance Graded Asphalt Binders and Hot Mix Asphalt (HMA) shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

B. Crack Filler: Crack filler shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Pavement).

C. Aggregate: Aggregate shall conform to M 43, No. 10.

D. Tack Coat: Tack Coat shall conform to M 140.

E. All materials for crack filling will be inspected, tested and as approved by the Engineer before being incorporated into the Work.

PART 3 EXECUTION

3.1 GENERAL

All cracks to be filled will be designated by the Engineer.

3.2 CRACK CLEANING AND PREPARATION

A. Existing filler that has deteriorated shall be removed using equipment capable of removing the material to the required depth without damaging the sides of the pavement within the crack. Equipment, which causes a "V" shaped groove, is prohibited. The Contractor shall be responsible for all damage to sound pavement as a result of Construction operations.

B. Cracks shall be cleaned by high pressure water blasting, abrasive blasting, oil free air blowing, by use of a heat lance, or a combination thereof as approved by the Engineer. Any operation may be suspended by the Engineer when weather conditions might create a hazard to the traveling public.

C. Cracks shall be completely dry before filling using methods approved by the Engineer.

D. Prepared cracks will be inspected by the Engineer for debris, adherent dust, and dryness prior to filling. Cracks rejected by the Engineer shall be re-cleaned and dried until satisfactory.

E. Cracks varying in width up to one and three-quarters inches (1-3/4″) shall be divided into segments. Portions of cracks having widths ranging from over one inch (1″) and up to one and three-quarters inches (1-3/4″) shall be sawn the full depth of the crack and one-eighth inch (1/8″) wider than the maximum width of the crack. The crack shall be cleaned of all debris as specified above. A tack coat shall be applied to the sides of the crack. The crack shall be repaired as specified in 32 01 17.59, (Hot Mix Asphalt Patch) using a surface mix approved by the Engineer. An appropriate asphalt content and mixing temperature shall be selected by the Contractor.

3.3 CRACK FILLING

A. Both the ambient and pavement surface temperature shall be at least forty-five degrees (45°) F and rising at the time of filler application, unless otherwise recommended by the manufacturer.

B. Hot applied filler materials for cracks from one-eighth inch to one inch (1/8″ to 1″) in width shall be heated as recommended by the manufacturer, in a double boiler, indirect heating kettle using oil as a heat transfer medium, or other equipment approved by the Engineer. The kettle shall have a mechanically operated agitator, recirculation pumps, and a positive thermostatic temperature control. The applicator wand and all connecting hoses shall be insulated. Overheating or direct heating of the filler is prohibited.

C. Filler that has been overheated, heated more than four (4) hours, or any amount of filler that remains in the applicator at the end of the day's operation shall be withdrawn and wasted. Prior to the start of each day's operation, the Contractor shall withdraw a

minimum of one (1) gallon of filler from the applicator wand to be considered as waste material.

D. Prepared cracks that have been approved by the Engineer shall be filled until the material is level to one-sixteenth inch (1/16″) below the pavement surface. Any filled crack not in conformance with this requirement two (2) hours after filling shall be refilled as directed by the Engineer.

E. Cracks that cannot be filled due to filler drainage into a large void shall be repaired by plugging the void with HMA Superpave four and seventy-five-hundredths (4.75) mm, or other suitable material approved by the Engineer, then filling the crack as specified above.

F. The Contractor shall remove excess filler from the surface of the pavement.

G. Field prepared flow panels of hot applied crack filler shall be submitted to the Engineer for the flow test a minimum of twice daily, or as directed by the Engineer.

H. Cracks shall be filled the same day they are prepared. Cracks that are not filled on the same day they are prepared shall be re-cleaned, dried, and filled.

I. Traffic shall not be permitted on the pavement surface until the crack filler has cured.

J. Filler that pulls loose within ninety-six (96) hours after opening the pavement to traffic shall be repaired by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for furnishing, hauling, and placing of all materials, crack shaping, crack filling, the removal and disposal of old filler and debris, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. Payment will not be made for wasted material.

B. Filler removal, saw cutting, crack shaping, and crack filler will be measured and paid for at the Contract Unit Price per linear foot.

C. Patching material for cracks will be measured and paid for per linear foot regardless of the width or depth of the crack.

32 01 29 RIDGED PAVEMENT REPAIR

32 01 29.64 REPAIRING PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of repairing plain, conventionally reinforced, or continuously reinforced portland cement concrete pavement as specified in the Contract Documents or as directed by the Engineer. Repairs are either Type I, six foot (6′) to less than fifteen feet (15′) in length or Type II, fifteen feet (15′) and greater in length. The minimum repair length shall be six feet (6′).

PART 2 PRODUCTS

2.1 MATERIALS

A. Refer to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Pavement) except as follows:

B. Graded Aggregate for Base Course: Graded aggregate for base course shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

C. Crusher Run Aggregate CR 6: Crusher run aggregate CR 6 shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

D. High Range Water Reducing Admixture: High range water reducing admixtures shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

E. Nonshrink Grout: Nonshrink grout shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

F. Epoxy Grout: Epoxy grout shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

G. Epoxy Adhesive: Epoxy resin bonding material shall consist of a thermosetting epoxy resin and a hardener. The individual components of mixed epoxy shall not settle or skin and shall contain no volatile solvents, lumps, or foreign materials. The epoxy shall conform to C 881. Unless otherwise specified, epoxy adhesive used for bearing and expansion pads shall be nonsagging. The manufacturer shall furnish certification. This certification shall be a document, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification or data sheet shall show actual test results for each required property of the type, grade, and class of epoxy submitted, and shall accompany each sample. The manufacturer shall supply actual bond test results for each batch submitted for use.

H. Concrete Mix Design (Modified Mix No. 6): Concrete shall be Mix No. 6 as specified in 03 30 00, Part 2, (Portland Cement Concrete Structures) except that the minimum cement factor shall be eight hundred (800) lb/yd^3, contain a high range water reducing admixture and have a minimum compressive strength of twenty-five hundred (2500) psi in twelve (12) hours. Testing shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures) except that cylinders shall remain in the molds until tests are conducted.

I. Field Control: Field control will be by compressive strength, cement content, slump, water/cement ratio and air entrainment. Acceptance will be based on a minimum compressive strength of three thousand (3000) psi in twenty-four (24) hours. If test results fall below the specified value, a new mix design shall be prepared by the Contractor as directed by the Engineer.

J. Polyester Grout: The Contractor may substitute polyester grout in lieu of epoxy grout providing the grout conforms to paragraph F. Cartridge type systems shall be identified with a batch or lot number.

K. Epoxy Adhesives: Epoxy adhesives shall conform to paragraph G and shall be Type IV, Grade 3, Class B and C, and shall be water insensitive.

L. Reinforcement: Reinforcement, including load transfer assemblies, tie bars, deformed steel bars and longitudinal tie devices shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Concrete Pavements) and shall be epoxy coated.

PART 3 EXECUTION

3.1 CONSTRUCTION

Areas to be repaired and type of repair will be determined by the Engineer. Prior to the start of repairs, the Contractor shall submit for approval, a proposed repair plan, including equipment, methods and procedures. The Contractor shall protect the repair area against damage from all causes. If any part of the repaired pavement is damaged, it shall be repaired or replaced by the Contractor at no additional cost to the City. Repairs shall be made in only one (1) lane at a time for each roadway.

3.2 EQUIPMENT

Refer to 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements).

3.3 WEATHER RESTRICTIONS

A. Weather restrictions shall be as specified in Division 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements) except that the Work shall be performed during the months of April through October, unless otherwise permitted in writing by the Engineer. When the range in daily temperature is expected to exceed fifteen degrees (15°) F, concrete placement will be permitted in the late afternoon after the existing pavement has achieved its maximum expansion, unless otherwise directed by the Engineer.

B. Cold weather protection shall conform to 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements) except that insulated blankets shall be used when the ambient air temperature is less than seventy degrees (70°) F.

3.4 SAW CUTS AND REMOVAL OF EXISTING PAVEMENT

A. Concrete slabs shall be removed by the lift out method in large sections. No other method of slab removal shall be used unless permitted by the Engineer. All areas where the pavement has been removed shall be repaired in the same working day.

B. If any portion of adjacent slabs is damaged due to the Contractor's operations, the damaged portions shall be repaired by the Contractor at no additional cost to the City.

C. Saw cuts and pavement removal procedures are as follows:

1. Plain and Conventionally Reinforced Portland Cement Concrete Pavement. Existing pavement shall be removed by making a perpendicular saw cut, full depth, for the full slab width using a diamond saw blade. Full depth saw cuts shall be spaced a minimum of two inches (2″) from and parallel to, longitudinal joints

between pavement slabs. When repairs are to be made on only one side of an existing transverse joint, the removal shall extend into the adjacent slab a sufficient distance to ensure that existing dowels are removed. The concrete slab shall be removed within one (1) week after the saw cuts have been made. Repairs shall be completed in a continuous operation.

2. Continuously Reinforced Portland Cement Concrete Pavement. Existing pavement shall be removed by making a perpendicular saw cut for the full slab width using a diamond saw blade. The concrete slab shall be removed within seventy-two (72) hours after the saw cuts have been made. This saw cut shall be two inches (2″) minimum depth, for the full width of the lane at the boundaries of the repair without cutting the steel reinforcement. The boundaries shall be a minimum of eighteen inches (18″) from the nearest transverse tight crack for normally spaced tight cracks and at least six inches (6″) from the nearest transverse crack when they are closely spaced. The Contractor shall saw cut, full depth, across the full width of the slab a minimum of twenty-two inches (22″) inside each boundary saw cut. Additional full depth saw cuts shall be made along all longitudinal edges not bounded by Construction joints. Concrete shall be removed to its full depth within the boundaries of the repair area. Bending existing reinforcement bars is prohibited.
3. The equipment used to remove concrete in the areas between each two inches (2″) and full depth saw cut shall be restricted to a maximum jackhammer size of sixty (60) lb and hand tools only. The existing pavement edge shall be neatly trimmed and vertical. A minimum of twenty-two inches (22″) of reinforcement shall remain exposed on each side of the repair. The Engineer will require the removal of any pavement breaking equipment from the project that could damage the adjacent concrete pavement. When the saw cuts close due to temperature, prior to removal of the existing slab, narrowly spaced, full depth, full width saw cuts shall be made to relieve pressure. The material between the narrowly spaced saw cuts or the longitudinal joint and the two inches (2″) minimum offset longitudinal cut shall be removed. Removal equipment shall be as specified above. Tie bars protruding from the longitudinal offset cut shall be cut flush with the existing concrete. All waste material shall be immediately removed from the repair site.
4. Any saw cuts that extend into adjacent slabs, curbs or gutter shall be sealed as specified in 32 13 73.12, (Joint Sealing of Portland Cement Concrete Pavements).

3.5 BASE AND SUBGRADE PREPARATION

Refer to 32 01 17.59, (Hot Mix Asphalt Patches) except that the subgrade for all types of repairs shall be moistened with water.

3.6 SUBGRADE DRAINS

The Engineer may direct that subgrade drains be constructed. The Work shall conform to 33 46 16.19, (Pipe Underdrains and Outlets). Additional Work shall be as directed by the Engineer.

3.7 FORMS

The forms used shall conform to 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements), or shall be as directed by the Engineer. Forms shall overlap the existing pavement on each side of the patch a minimum of one foot (1′) and be securely fastened to prevent movement when concrete is placed. The Contractor shall

excavate the adjacent shoulder the width of the form plus six inches (6″) to provide space for the forms. After removal of the form, the excavated shoulder area shall be repaired using the same type of material as used in the original shoulder.

3.8 REINFORCEMENT

A. Reinforcement shall conform to the Contract Documents and 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements). Doweled joints shall be located at the slab face closest to the original doweled joint location.

B. Holes having a diameter one-quarter inch (1/4″) larger than the dowels, load transfer tie bars and longitudinal tie devices shall be drilled into the face of the existing slab at mid depth. After drilling, the hole shall be blown out and allowed to dry. The dowels, load transfer tie bars and longitudinal tie devices shall be grouted or epoxied into place. The alignment of the reinforcement shall be in the direction of the pavement and parallel to the plane of the surface.

C. A plastic grout retention disk conforming to the Contract Documents shall be placed on each dowel to prevent loss of the bonding material.

D. Reinforcement steel bars for continuously reinforced portland cement concrete pavement shall be the same size and spacing as the existing steel and shall be spliced to the exposed steel of the existing pavement by lapping, welding or using a mechanical device that is approved by the Engineer. For lap splices, the steel reinforcement shall be lapped a minimum of twenty-two inches (22″) and secured with tie wires. Longitudinal steel reinforcement bars shall be continuous for the full length of the repair and the amount of steel in the repair area shall be at least equal to the amount of steel in the existing pavement. The reinforcement steel bars shall be supported by chairs or as approved by the Engineer.

E. For plain and conventionally reinforced pavement, the protruding ends of the dowel bars shall be coated with a water insoluble lubricant approved by the Engineer.

3.9 JOINTS

A. Joints shall conform to 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavements) Part 3 and the Contract Documents.

B. All joints shall be sealed as specified in 32 13 73.12, (Joint Sealing of Portland Cement Concrete Pavements).

3.10 CONCRETE PLACEMENT

A. Concrete placement shall conform to 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements). Prior to placing concrete, the exposed vertical surfaces of all adjacent concrete shall be cleaned.

B. Refer to 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements) for weather requirements. The temperature of the concrete at placement shall be fifty degrees to ninety degrees (50° to 90°) F.

C. Concrete for continuously reinforced portland cement concrete pavement shall be placed when the air temperature is a minimum forty degrees (40°) F and rising. When the range in daily temperature is expected to exceed fifteen degrees (15°) F, placement of concrete will be permitted in the late afternoon after the existing pavement has achieved maximum expansion unless otherwise directed by the Engineer.

D. Plain and continuously reinforced concrete pavement repairs shall be cast in one full depth operation. Conventionally reinforced concrete pavement repairs shall be placed in two (2) equal lifts with the wire mesh laid on the surface of the first lift.

E. All concrete shall be vibrated.

3.11 FINISHING

Following the concrete placement, the surface shall be struck off to the finished grade by means of an adjustable steel or wooden template and floated to a smooth finish. The repair shall be screeded longitudinally to provide uniformity of ride to adjacent pavement. The final surface shall match the contour of the existing roadway. The Contractor shall provide a metal straightedge and perform surface checks as specified in 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements).

3.12 CURING

The concrete shall be cured as specified in 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements) except that the curing shall continue for twelve (12) hours after placement of the concrete or until the repair is put into service.

3.13 EMERGENCY FILLER

The Contractor shall have readily available sufficient crusher run aggregate CR 6 to completely fill the void of the repair area. The material shall be placed and compacted in the void and covered with a steel plate when directed by the Engineer. At the beginning of the next day's Work, this material shall be completely removed using procedures which shall not disturb the subgrade, dowels, load transfer tie bars, load transfer assemblies or reinforcement that has been previously placed.

3.14 STEEL PLATES

The Contractor shall have an ample supply of twelve feet by fourteen feet by one inch (12′ X 14′ X 1″) thick steel plates available on the project to cover emergency filler or be placed over the patch area until the concrete has developed sufficient strength to carry traffic. Contractor shall install steel plates on accordance with City Standard, BC-576.17. Contractor shall fill out the City Steel Plate Installation form showing installation and expected removal dates. The form will be faxed to the Steel Plate Inspection Section at a number designated by the Engineer.

3.15 UNACCEPTABLE REPAIRS

Pavement repairs that have been damaged by traffic or other causes or are not in conformance with the Contract Documents shall be removed and replaced by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. Portland Cement Concrete Pavement Repairs will be measured in place and paid for at the Contract Unit Price for one or more of the items as specified in the Contract Documents. The payment will be full compensation for saw cuts, furnishing, hauling, placing of all materials, removal and disposal of old concrete, grout, drilled holes, chairs, all tie devices, reinforcement, epoxy coating, steel plates, emergency filler, joint sealing, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Steel plates and emergency filler shall remain the property of the Contractor at the completion of the project.

C. Plain Portland Cement Concrete Pavement Type I Repairs, per square yard.

D. Plain Portland Cement Concrete Pavement Type II Repairs, per square yard.

E. Conventionally Reinforced Portland Cement Concrete Pavement Type I Repairs, per square yard.

F. Conventionally Reinforced Portland Cement Concrete Pavement Type II Repairs, per square yard.

G. Continuously Reinforced Portland Cement Concrete Pavement Type I Repairs, per square yard.

H. Continuously Reinforced Portland Cement Concrete Pavement Type II Repairs, per square yard.

I. Removal of unsuitable material and refill, per cubic yard. The payment will also include excavation and disposal of unsuitable material, backfilling with aggregate, and compaction.

J. Subgrade Drains will be measured and paid for as specified in the applicable portions of Division 33 46 16.19, (Pipe Underdrains and Outlets).

K. Shoulder Repairs per square yard. Repairs to existing shoulders necessitated by the placement of forms are also included.

32 01 30 OPERATION AND MAINTENANCE OF SITE IMPROVEMENTS

32 01 30.10 PATCH EXISTING PAVEMENT AND RESET UTILITY SERVICES

PART 1 GENERAL

1.1 DESCRIPTION

The Work performed in conjunction with the placement or repair of utility lines consists of trenching, shoring, sub-grade replacement, base course replacement, surface course replacement and pavement marking replacement for composite pavements, PCC pavements, flexible pavements, curb replacement, combination curb and gutter

replacement, sidewalk replacement, the adjusting and resetting of all manhole frames, inlet frames and other utility service structures in accordance with these Specifications, Plans and/or standards.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregates for Hot Mix Asphalt (HMA): Refer to 32 12 16.13, (Plant Mix Asphalt Pavement).

B. Performance Graded Asphalt Binders and Hot Mix Asphalt: Refer to 32 12 16.13, (Plant Mix Asphalt Pavement).

C. Portland Cement: Refer to 03 30 00, (Portland Cement Concrete Structures).

D. Water: Refer to 03 30 00, (Portland Cement Concrete Structures).

E. Composition of Concrete Mixture: Refer to 03 30 00, (Portland Cement Concrete Structures). Concrete Mix Design (Modified Mix No. 6) shall be used for the pavement replacement. Concrete shall be Mix No. 6 as specified in 03 30 00, (Portland Cement Concrete Structures) except that the minimum cement factor shall be eight hundred (800) lb/yd^3, contain a high range water reducing admixture and have a minimum compressive strength of twenty-five hundred (2500) psi in twelve (12) hours. Testing shall conform to 03 30 00, (Portland Cement Concrete Structures) except that cylinders shall remain in the molds until tests are conducted.

F. High Range Water Reducing Admixtures: Refer to 03 30 00, (Portland Cement Concrete Structures).

G. Fine and Coarse Aggregate (Concrete): Refer to 03 30 00, (Portland Cement Concrete Structures).

H. Crusher Run Aggregate CR 6: Refer to 32 11 23.10, (Aggregate Base Course).

I. Graded Aggregate: Refer to 32 11 23.10, (Aggregate Base Course).

J. Sand: Refer to 32 11 23.10, (Aggregate Base Course).

K. Hydrated Lime: Refer to 31 23 13.10, (Lime Treated Subgrade).

L. Mortars: Refer to 04 21 13, (Brick Masonry).

M. Brick for Masonry and Sewers: Refer to 04 21 13, (Brick Masonry).

N. Preformed Joint Filler: Refer to 03 30 00, (Portland Cement Concrete Structures).

O. Joint Sealing Compound: Refer to 03 30 00, (Portland Cement Concrete Structures).

P. Reinforcement: Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

Q. Flowable Backfill: Refer to 31 23 23.33, (Flowable Fill).

PART 3 EXECUTION

3.1 GENERAL

A rating called an Overall Condition Index (OCI) has been assigned to each roadway in the City. The assigned Index determines surface course restoration as provided in this Specification. The existing pavement shall be removed with a minimum disturbance to the base material and the faces of the remaining pavement shall be plane without ragged edges. The use of equipment that could damage the existing pavement is prohibited. If any part of the existing pavement is damaged, it shall be repaired or replaced by the Contractor at no additional cost to the City. Repairs shall be made in only one (1) lane at a time for each roadway.

3.2 EXISTING PAVEMENT

Each day the Contractor shall complete all repairs for which excavation has been completed or the excavation shall be covered with steel plates. Open excavated areas at the end of the Workday are prohibited.

3.3 EMERGENCY FILLER

A. When the existing pavement is a flexible pavement, the Contractor shall have readily available sufficient cold patch material to completely fill the void of the repair area. This material shall be subject to the approval of the Engineer and shall be placed and compacted in the void when directed by the Engineer. At the beginning of the next day's Work, this material shall be completely removed as directed by the Engineer.

B. When the existing pavement is a rigid pavement, the Contractor shall have readily available sufficient crusher run aggregate CR 6 to completely fill the void of the repair area. The material shall be placed and compacted in the void and covered with a steel plate when directed by the Engineer. At the beginning of the next day's Work, this material shall be completely removed using procedures which shall not disturb the subgrade, dowels, load transfer tie bars, load transfer assemblies or reinforcement that has been previously placed.

3.4 MAINTENANCE OF TRAFFIC

Procedure for maintenance of traffic shall be approved by the Engineer before any existing pavement is removed.

3.5 STEEL PLATES

The Contractor shall have an ample supply of twelve foot by fourteen foot by one inch (12′ X 14′ X 1″) thick steel plates available on the project to cover emergency filler or be placed over the patch area until the concrete has developed sufficient strength to carry traffic. The Contractor shall place the appropriate notification signs ("Steel Plates") if it uses steel plates at any point in the processes described herein. Further, the Contractor shall notify the Engineer before placing any steel plates in the Public Right-of-Way. The Contractor shall complete the City Steel Plate Installation form and fax it to the steel plate inspection section at the number provided by the Engineer, prior to installing any steel plates. Refer to Baltimore City Standard BC 576.17 for additional details.

3.6 PATCH CONSTRUCTION

A. Flexible Pavement

Refer to Baltimore City Standard Detail 576.19 for additional information on this patch Construction. All material and specification references on the aforementioned detail will be Superseded by this Specification.

1. Trench Excavation: The Contractor shall cut the pavement full depth along the trench outline by means of a power saw.
2. Restoration of Base Course.

   a. Restoration Cut: The Contractor shall cut the pavement parallel to the trench and wider than the trench on both sides of the excavation and across the ends in accordance with the aforementioned standard detail. The existing pavement materials that are removed shall be disposed of immediately by the Contractor.

   b. Replacement of Base Course: The top six inches (6″) of the trench shall be filled with crusher run aggregate CR 6, compacted in accordance to 32 11 23.10, (Aggregate Base Course). The Contractor shall protect the aggregate base or subgrade after preparation. Note that if the Contractor chooses the flowable fill option, aggregate subbase is not needed. Prior to placing the HMA, the exposed vertical surface of all adjacent pavements shall be thoroughly cleaned and all vertical surfaces shall be tack coated. The tack coat shall be uniformly applied to the surface at a rate of one-hundredth to five-hundredths (0.01 to 0.05) gal/yd^2 as directed by the Engineer. The HMA mixture may be spread by shovel, rake or other method approved by the Engineer. Placing HMA on a frozen base is prohibited. Use Hot Mix Asphalt Superpave nineteen (19.0) mm for the base course PG64-22, Level 2. The maximum lift thickness shall be three inches (3″) and the minimum lift thickness shall be two inches (2″). The temperature of the mixture shall be a minimum of two-hundred twenty-five degrees (225°) F at the time of placement. Apply a tack coat between each lift as described above. Manual operation will be permitted for placement of the HMA. Patch construction shall conform to the applicable portions of 32 01 17.59, (Hot Mix Asphalt Patch). Cores, control strip and pavement profile measurements are waived. Equipment, placement, compaction and quality control procedures shall be as approved by the Engineer. Where the Engineer determines the areas involved to be of narrow or irregular section where mechanical paving equipment is impractical, hand tamping will be permitted. Compaction tests on hot mix asphalt courses will be waived in these narrow or irregular areas. Where areas are of sufficient size to permit the use of mechanical paving equipment, use of such paving equipment and compaction tests shall be required.

3. Surface Course Restoration

   a. For Overall Condition Index (OCI) of 3, 4, or 5:

      1) If the existing wearing surface has an OCI of 3, 4 or 5 then the surface course can be restricted to the limits of the full depth patch construction. The surface course shall be Hot Mix Asphalt Superpave

twelve and five-tenths (12.5) mm PG64-22, level 2, two inches (2″) thick.

2) Whenever a utility cut is within five feet (5′) of another one, both cuts shall be encapsulated in a single patch by either milling away the intervening existing surface course to allow for a single surface course patch or by combing the two (2) patches with a single full depth pavement patch.

b. For Overall Condition Index (OCI) of 1 or 2:

1) If the existing wearing surface has an OCI of 1 or 2 then milling and overlaying shall be used to extend the limits of the surface course beyond the limits of the full depth patch in accordance with the following:

Longitudinal Trenches: The Contractor shall mill and overlay the entire width of the affected lane(s).
Transverse Trenches: The Contractor shall mill and overlay ten feet (10') on each side of the trench. The length shall be the full width of the affected lane(s).

The surface course within the limits of the full depth path shall be Hot Mix Asphalt Superpave twelve and five-tenths (12.5) mm PG64-22, level 2, two inches (2″) thick.

2) Mill and Overlay: Remove the top two inches (2″) of the existing surface asphalt pavement by clean saw cut, within the limits as determined above. Resurface with 2 inches (2″) of Hot Mix Asphalt Superpave twelve and five-tenths (12.5) mm for surface course PG64-22, level 2.

3) Road Conditions Ratings will be shown in the Contract Documents and/or the permit documents.

B. Flexible Surface-Ridge Base Pavements

Refer to Baltimore City Standard Detail 576.20 for additional information on this patch construction. All material and specification references on the aforementioned detail will be superseded by this Specification.

1. Trench Excavation: The Contractor shall cut the pavement full depth along the trench outline by means of a power saw.
2. Restoration of Base Course.

a. Restoration Cut. Existing pavement shall be removed by making a perpendicular full depth saw cut for the full slab width using a diamond saw blade in accordance with the aforementioned standard detail. Saw cuts close to the transverse joint shall be limited to three inches (3″) in depth to avoid damaging the transfer bars. Pneumatic tools shall be used to remove the remaining portion of the base course next to the transverse joint. Salvage transverse tie bars where pavement is removed at an existing transverse joint. Repairs shall be completed in a continuous operation. All

waste material shall be immediately removed from the repair site. Any saw cuts that extend into adjacent slabs, curbs or gutter shall be sealed with joint sealing compound. If any portion of adjacent slabs is damaged due to the Contractor's operations, the damaged portions shall be repaired by the Contractor at no additional cost to the City.

b. Replacement of Base Course. The top six inches (6″) of the trench shall be filled with compacted sub-base in accordance with 32 11 23.10, (Aggregate Base). The Contractor shall place portland cement concrete base course using modified Mix No. 6 cement concrete capable of achieving a compressive strength of twenty-five hundred (2500) psi within twelve (12) hours. The bottom of the new base course shall be even with the bottom of the existing base course or the new base course shall be constructed seven inches (7″) thick, whichever is greater. The top of the new base course shall be flush with the existing concrete slab. At existing transverse joints replace three-quarters inch (3/4″) expansion material and expansion sleeves. Concrete base shall be placed in accordance with 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavements) and shall be carefully worked with tampers, spades or other tools to completely fill the gap. Particular care will be taken to work the fresh concrete into the irregularities left by the trimming of the existing pavement. Plain concrete pavement repairs shall be cast in one (1) full depth operation. Conventionally reinforced concrete pavement repairs shall be placed in two (2) equal lifts with the reinforcing laid on the surface of the first lift. All concrete shall be vibrated. Following the concrete placement, the surface shall be struck off to the finished grade by means of an adjustable steel or wooden template and floated to a smooth finish. The repair shall be screeded longitudinally to provide uniformity of ride to adjacent pavement. The final surface shall match the contour of the existing roadway. The concrete shall be cured as specified in 32 23 13.10, (Plain and Reinforced Portland Cement Concrete Structures).

c. Temporary Feathering. Between the time that a concrete base course has cured and the final asphalt surface is applied, the Contractor shall feather all edges from the existing pavement surface to the concrete base course with temporary Hot Mix Asphalt at a rate of three inches (3″) per every inch of elevation.

3. Surface Course Restoration

a. For Overall Condition Index (OCI) of 3, 4 or 5:

1) If the existing wearing surface has an OCI of 3, 4 or 5 then the surface course can be restricted to the limits of the flexible pavement cut back shown on the Standard Detail 576.20. Resurface with two inches (2″) of Hot Mix Asphalt Superpave twelve and five-tenths (12.5) mm for surface course PG64-22, level 2. Under the surface course provide Hot Mix Asphalt Superpave nineteen (19.0) mm for binder course PG64-22, Level 2. Use a minimum course thickness of three inches (3″) with the maximum of four inches (4″). In all cases, the hot mix asphalt shall be placed in accordance with 32 01 17.59, (Hot Mix Asphalt Patch). When the Engineer determines the areas involved to be narrow or irregular

sections and where mechanical paving equipment is impractical, hand tamping will be permitted. Compaction tests on hot mix asphalt courses will be waived in these narrow or irregular areas. Where areas are of sufficient size to permit the use of mechanical paving equipment, use of such paving equipment and compaction tests shall be required. Where the surface repair is feathered out, the joints shall be smoothed with hot irons as directed.

2) Whenever a utility cut is within five feet (5′) of another one, both cuts shall be encapsulated in a single patch by either milling away the intervening existing surface course to allow for a single surface course patch or by combing the two (2) patches with a single full depth pavement patch.

b. For Overall Condition Index (OCI) of 1 or 2:

1) If the existing wearing surface has an OCI of 1 or 2 then milling and overlaying shall be used to extend the limits of the surface course beyond the limits of the flexible pavement cut back shown on the aforementioned detail in accordance with the following:

Longitudinal Trenches: The Contractor shall mill and overlay the entire width of the affected lane(s).
Transverse Trenches: The Contractor shall mill and overlay ten feet (10′) on each side of the trench. The length shall be the full width of the affected lane(s).

Resurface the flexible pavement cut back area in accordance with 3.6 B.

2) Mill and Overlay: Remove the top two inches (2″) of the existing surface asphalt pavement by clean saw cut, within the limits as determined above. Resurface with two inches (2″) of Hot Mix Asphalt Superpave twelve and five-tenths (12.5) mm for surface course PG64-22, level 2.

3) Road Conditions Ratings will be shown in the Contract Documents and/or the permit documents.

C. Rigid Pavement

Refer to Baltimore City Standard Detail 576.18 for additional information on this patch construction. All material and specification references on the aforementioned detail will be superseded by this Specification.

1. Trench Excavation: The Contractor shall cut the pavement full depth along the trench outline by means of a power saw.
2. Restoration of Pavement.

a. Restoration Cut: See Section 3.6, B, 3, a.
b. Replacement of Pavement: See Section 3.6, B, 3, b.

3.7 CROSSWALKS AND SIDEWALKS

A. Crosswalks: If a utility cut intersects a crosswalk(s) of any material other than that of the surrounding roadway, the permanent restoration of the crosswalk(s) must be restored it to its original condition with materials identical to those of the original crosswalk(s).

B. Sidewalks: If a sidewalk(s) is affected by a utility cut, the Contractor must restore it to its original condition with materials identical to those of the original sidewalk. All sidewalks shall be removed and replaced to the nearest existing expansion or contraction joint on either side of the utility cut.

3.8 PAVEMENT MARKING

If any pavement markings are affected by a utility cut, the Contractor shall replace them with temporary pavement markings within forty-eight (48) hours. Immediately upon the completion of a permanent repair, the Contractor shall replace temporary pavement markings with permanent ones.

3.9 UTILITY ADJUSTMENTS

Utility adjustments shall be made in accordance with Standard BC-576.22 (sheets 1 through 3 of 3). The frames shall be adjusted to the new grade using brick masonry and mortar. Wood blocks or pegs will not be permitted. All reset frames shall be protected from traffic for a period of twenty-four (24) hours after the concrete is in place. No Hot Mix Asphalt shall be placed around the utility structures or in areas of pavement repairs until the concrete has set for a period of twenty-four (24) hours. The Contractor shall be held responsible for the new grade of the adjusted structures and any structures determined by the Engineer to be off grade shall be reset to the correct grade at the Contractor's expense.

3.10 FLOWABLE FILL

If flowable fill is used as backfill, a foot of sand compacted in accordance with 32 11 23.10, (Aggregate Base), shall be placed over any utility before the trench is backfilled.

3.11 UNACCEPTABLE REPAIRS

Pavement repairs that have been damaged by traffic or other causes or are not in conformance with the Contract Documents shall be removed and replaced by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The concrete will be measured per cubic yards of concrete pavement completed and accepted. Measurements will be based on field measurement of areas to be filled.

B. Hot Mix Asphalt Pavement will be measured per ton completed and accepted.

C. Method of Measurement for correction of unsatisfactory subgrade will be made according to the particular item involved.

D. The resetting of manholes, inlets and other utility service structures will not be measured.

4.2 PAYMENT

A. The quantity of concrete pavement or base shall be paid for at the Contract Unit Price Bid per cubic yard for the applicable unity of cement concrete.

B. The quantity of hot mix asphalt pavement or base shall be paid for at the Contract Unit Price Bid per ton for the applicable unit of Hot Mix Asphalt.

C. The prices shall constitute full compensation for the placing all materials, tack coat, steel plates, temporary filler, mixing, placing and furnishing of the patch complete in place as herein specified including all materials, reinforcement and the tie devices, the preparation of materials, concrete, tools, equipment, labor and all other items necessary to complete the Work.

D. The cost of the saw cutting, milling, grinding, removal, disposal, trimming of the existing surfacing and base, subgrade preparation and the resetting of manhole frames, inlet frames and other utility service structures, shall be included in the Contract Unit Price Bid for the particular type of base course being installed.

32 11 00 BASE COURSES

32 11 23.10 AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of constructing base courses using one of the following as specified in the Contract Documents or as directed by the Engineer:

1. Graded aggregate without a stabilizing agent.
2. Plant mixed graded aggregate with a portland cement stabilizing agent.
3. Bank run gravel.
4. Sand aggregate.

PART 2 PRODUCTS

2.1 MATERIALS

A. Graded Aggregate for Base Course

1. This section covers the material details, quality requirements, and test methods applicable to aggregates. Grading requirements are outlined in Table A; physical properties in Table B. Force drying may be used in the preparation of samples for grading tests conducted in the field.
2. Steel Slag: Steel slag may be used for chip seal surface treatment, but it shall not be used for any other aggregate.

TABLE A – AGGREGATE GRADING REQUIREMENTS TEST METHOD T-27

MATERIAL		SIEVE SIZE														
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 10	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200
CRUSHER RUN AGGREGATE CR -6 (f)(g)		—	100	90–100	—	60–90	—	—	30–60	—	—	—	—	—	—	—	0–15
BANK RUN GRAVEL — SUBBASE		100	—	—	90–100	—	60—100	—	—	—	35–90	—	—	20–55	—	—	5–25
GRADED AGGREGATE — BASE DESIGN RANGE (a)		—	100	95–100	—	70–92	—	50–70	35–55	—	—	—	12–25	—	—	—	0–8
TOLERANCE (b)		—	–2	±5	—	±8	—	±8	±8	—	—	—	±5	—	—	—	±3 (c)
BANK RUN GRAVEL — BASE		100	—	—	85–100	—	60–100	—	—	—	35–75	—	—	20–50	—	—	3–20
COARSE AGGREGATE - PORTLAND CEMENT CONCRETE	57 and UNDER-DRAIN (h)	—	—	100	95–100	—	25–60	—	0–10	0–5	—	—	—	—	—	—	—
	67	—	—	—	100	90–100	—	20–55	0–10	0–5	—	—	—	—	—	—	—
	7	—	—	—	—	100	90–100	40–70	0–15	0–5	—	—	—	—	—	—	—
FINE AGGREGATE — PORTLAND CEMENT CONCRETE, UNDERDRAIN & PNEUMATIC MORTAR (d)		—	—	—	—	—	—	100	95–100	—	—	45–85	—	—	5–30	0–10	—
COARSE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE		—	—	—	100	90–100	—	10–50	0–15	—	—	—	—	—	—	—	—
FINE AGGREGATE — LIGHTWEIGHT PORTLAND CEMENT CONCRETE (d)		—	—	—	—	—	—	100	85–100	—	—	40–80	—	—	10–35	5–25	—
FINE AGGREGATE/SAND MORTAR and EPOXIES (d)		—	—	—	—	—	—	—	100	95–100	—	—	—	—	—	0–25	0–10
MINERAL FILLER		—	—	—	—	—	—	—	—	—	—	—	100	—	95–100	—	70–100
CRUSHED GLASS (e)		—	—	—	—	100	—	—	0–55	—	—	45–85	—	—	—	0–10	—

Note: (a) To establish target values for design. (b) Production tolerance. (c) Plus or minus (±2) for field grading (omitting T 11). (d) Fine aggregate includes natural or manufactured sand. (e) Crushed glass shall not contain more than one percent (1%) contaminants by weight. (f) Not to be used in the structural part of any City project. (g) Recycled asphalt pavement may be used as a component not to exceed fifteen percent (15%) and is not subject to aggregate physical property requirements in TABLE B.

TABLE B – AGGREGATE PHYSICAL PROPERTY REQUIREMENTS

MATERIAL TYPE I	TEST METHOD										
	SPECIFICATIONS	T 90	T 104	T 112	T 113	T 112 & T 113	T 11	T 113	D 4791 (a)	T 96	T 21
		PI max	SODIUM SULFATE SOUND-NESS % max	CLAY LUMPS & FRIABLE PARTICLES % max	CHERT; LESS THAN 2.40 Sp Gr % max	SUM OF CLAY LUMPS, FRIABLE PARTICLES & CHERT % max	MATERIAL FINER THAN No.200 SIEVE % max	COAL & LIGNITE % max	FLAT & ELONGATED % max	LOS ANGELES ABRASION % max	ORGANIC IMPURITIES max
CRUSHER RUN AGGREGATE CR-6 (h)	D 2940	6	12	—	—	—	—	—	15	50	—
BANK RUN GRAVEL — SUBBASE	D 2940	9	12	—	—	—	—	—	—	50	—
GRADED AGGREGATE — BASE	D 2940	6	12	—	—	—	—	—	15	50	—
BANK RUN GRAVEL — BASE	D 2940	9	12	—	—	—	—	—	—	50	—
COARSE AGGREGATE — PCC (b)	M 80 CLASS A	—	12	2.0	3.0	3.0	1.0(c)	0.5	12	50	—
FINE AGGREGATE — PCC (b)(d)	M 6 CLASS B	—	10	3.0	—	—	4.0(e)	1.0	—	—	3.0
COARSE AGGREGATE — LIGHTWEIGHT PCC	M 195	—	—	2.0	—	—	—	—	12	—	—
FINE AGGREGATE — LIGHTWEIGHT PCC (f)	M 195	—	—	2.0	—	—	—	—	—	—	3.0
FINE AGGREGATE /SAND MORTAR & EPOXIES	M 45	—	10	1.0	—	—	—	0.5	—	—	3.0
MINERAL FILLER (g)	M 17	NP	—	—	—	—	—	—	—	—	—
CRUSHED GLASS	M 80	—	12	—	—	—	—	—	—	45	—

See next page for Notes to **TABLE B – AGGREGATE PHYSICAL**

Notes for **TABLE B – AGGREGATE PHYSICAL**

(a) Dimensional ratio of calipers shall be 5:1.
(b) Coarse and fine aggregate for PCC shall be tested for alkali silica reactivity (ASR) as specified in Maryland Standard Methods of Tests 212.
(c) 1.5 if material passing No. 200 sieve is dust of fracture, free of clay or shale.
(d) In areas exposed to traffic, manufactured sand shall have a minimum ultimate polish value of eight (8), based on the parent rock.
(e) Five (5.0) for concrete not subject to surface abrasion.
(f) Fine aggregate conforming to M 6 may be used if the lightweight concrete does not exceed the maximum unit weight specified in the Contract Documents.
(g) Fly ash shall have a maximum of twelve percent (12%) loss on ignition.
(h) Other approved inert materials of similar characteristics may be used provided they conform to these provisions. When crushed reclaimed concrete is used, the soundness loss by five (5) cycles of the magnesium sulfate test shall not exceed eighteen percent (18%) when tested as specified in T 104.

B. Bank Run Gravel for Base Course: See Part 2.1A

C. Sand Aggregate Base Course: See Part 2.1A
Coarse Aggregate: See Part 2.1A, Size No. 57
Fine Aggregate: 31 23 16.12, (Select Borrow Excavation)

D. Portland Cement: Section 03 30 00, Part 2, (Portland Cement Concrete Structures) Type I or IA.

E. Emulsified Asphalt

1. Emulsified asphalts shall conform to M 140 or M 208 with the following exceptions:

a. Cement mixing tests are waived.
b. Grade SS-1 viscosity shall be fifty to four hundred (50 to 400) seconds at seventy-seven degrees (77°) F.
c. Maximum of three percent (3.0%) by volume of oil distillate.
d. The sieve test requirement for field samples shall be a maximum of four-tenths percent (0.4%).

F. Production Plant, reference Section 03 30 43, (Production Plants) and 03 30 53.01, Part 2, (Miscellaneous Structures).

G. Water: shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed one thousand (1000) ppm.

H. Moisture and Dust Control Agents

1. Calcium Chloride: Solid calcium chloride shall conform to M 144, Type S, Grade I, Class A. Calcium chloride in solution shall contain a minimum of thirty percent (30%) salts. The solution shall be made using potable water in a quantity designated by the Engineer. When analyzed in conformance with Maryland Standard Methods of Tests (MSMT) 601, the residue shall conform to M 144.
2. Magnesium Chloride: Magnesium chloride flakes shall conform to the following:

TEST PROPERTY	SPECIFICATION LIMITS
Magnesium Chloride $MgCl_2$, %	46.0 – 47.0
Calcium Chloride $CaCl_2$, %	2.0 – 3.0
Potassium Chloride KCl, %	0.5 – 1.0
Sodium Chloride NaCl, %	0.5 – 1.0
Sulfates, % max	0.05

3. Magnesium chloride, when used as a solution, shall contain thirty percent to thirty-two percent (30% to 32%) solids.

PART 3 EXECUTION

3.1 CONSTRUCTION

A. At least thirty (30) days prior to the start of constructing the base course, the Contractor shall submit the proposed plants, equipment, and material sources to the Engineer for approval.

B. The Contractor shall protect the subgrade and base against damage from all causes. Any part of the subgrade or base that is damaged shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the City.

C. Excavation for widening shall be limited to an area which can be backfilled the same working day using graded aggregate base course. The temporary graded aggregate base wedge shall be maintained with a four to one (4:1) or flatter fill slope. The material shall be compacted as directed by the Engineer. The graded aggregate base wedge shall remain in place until placement of the hot mix asphalt base.

3.2 EQUIPMENT

All equipment, including the production plant and on-site equipment, shall be subject to approval by the Engineer. The plant shall be ready for inspection by the Engineer at least forty-eight (48) hours prior to the start of Construction operations.

3.3 WEATHER RESTRICTIONS

A. Temperature and Surface Conditions: Graded aggregate stabilized with portland cement shall be placed only when the ambient air and surface temperature is at least forty degrees (40°) F and rising. Graded aggregate, bank run gravel and sand aggregate base shall be placed only when the ambient air and surface temperature is at least thirty-two degrees (32°) F and rising. Placing material on a frozen subgrade is prohibited.

B. Cold Weather Protection: The plant mixed graded aggregate stabilized base shall be protected from freezing during the seven (7) day curing period.

C. Precipitation: Construction during precipitation is prohibited. When precipitation has occurred during the previous twenty-four (24) hours, the Engineer will determine if the subgrade is sufficiently dry. Any material en route from the plant to the job site may be placed at the Contractor's risk.

3.4 SUBGRADE PREPARATION

The approved subgrade set to final line and grade shall be completed at least five hundred feet (500′) ahead of the base course or as directed by the Engineer before the base course Construction begins. The foundation shall be constructed as specified in 31 24 13.10, (Embankment and Subgrade) and 31 23 13, (Select Backfill) and the Contract Documents, and as approved by the Engineer. If traffic, including Construction equipment, is allowed to use the subgrade foundation or preceding layer, it shall be distributed over the entire width of the course to aid in obtaining uniform and thorough compaction. If ruts are formed, they shall be removed by reshaping and recompacting the affected area as specified in 31 24 13.10, (Embankment and Subgrade).

3.5 STABILIZED GRADED AGGREGATE BASE MIX

The amount of portland cement shall be determined as specified in Maryland Standard Methods of Tests (MSMT) 321.

3.6 BANK RUN GRAVEL BASE MIX

The Contractor will be permitted to mix or blend materials using chemical additives approved by the Engineer.

3.7 SAND AGGREGATE BASE MIX

The mixture shall contain thirty-five percent to forty percent (35% to 40%) coarse material as measured by dry weight of the total mix.

3.8 TRANSPORTATION

Mixed base materials shall be handled and transported in a manner that minimizes segregation and loss of moisture. All loads shall be covered in conformance with state laws unless hauling is off road and is approved by the Engineer. Dumping into piles, hauling over the completed base course, and stockpiling of material on the job site is prohibited unless approved by the Engineer.

3.9 SPREADING

The base material shall be uniformly spread without segregating the coarse and fine particles, in layers of approximately equal thickness, to provide the specified planned depth. Shoulders or berms not less than two feet (2′) wide shall be built up on each side of the base to the top elevation of each uncompacted layer unless the base is placed against concrete curbs or gutters.

3.10 GRADE OR FINISHED SURFACE CONTROL

The surface of the base material shall be shaped to the required lines, grades and cross section specified in the Contract Documents. Grades shall be set longitudinally and transversely with fixed controls having a maximum spacing of twenty-five feet (25′). The surface material shall be compacted and smoothed over its full width using a smooth faced steel wheeled roller or, if rolling is not feasible, by mechanical tampers and vibratory compactors as approved by the Engineer. The finished grade shall not deviate more than one-half inch (1/2″) from the established grade.

3.11 COMPACTION

A. Immediately after placement, the base material shall be compacted to the required density. During compaction operations, the moisture content of the material shall be maintained within two percent (2%) of the materials optimum moisture. The optimum moisture content and maximum dry density shall be determined as follows:

1. Sand Aggregate Base and Bank Run Gravel Base: T 180.
2. Graded Aggregate Base and Graded Stabilized Aggregate Base: Maryland Standard Method of Tests (MSMT) 321.

B. Graded aggregate for base, bank run gravel base, and sand aggregate base shall be compacted to a minimum density of ninety-seven percent (97%) of the maximum dry density. Graded stabilized aggregate base shall be compacted to a minimum dry density of ninety-five percent (95%) of the maximum dry density. In place density shall be measured as specified in Maryland Standard Method of Tests (MSMT) 350 or 352.

C. Compaction operations, except on super elevated curves, shall begin at the sides of the course, overlap the shoulder or berm at least one foot (1′) and progress toward the center parallel to the center line of the roadway. Super elevated curve compaction shall begin at the low side of the super elevation and progress toward the high side. The compaction operation shall continue until all compaction marks are eliminated.

3.12 GRADED STABILIZED AGGREGATE BASE PROTECTION AND CURING

A. When graded stabilized aggregate base is used, the spreading, compacting and shaping shall be completed within three (3) hours after the mixing water, cement and aggregate have come in contact. Any section not conforming to these requirements shall be reconstructed as directed by the Engineer at no additional cost to the City. The surface of the stabilized aggregate base course shall be maintained in a moist condition until the emulsified asphalt seal coat is applied. The emulsified asphalt shall be applied by distributing equipment as specified in the Contract Documents at the rate of two-tenths (0.2) gal/yd^2. Ponding of the emulsified asphalt shall be avoided. If ponding occurs, the Contractor shall use a sand blotter or an equivalent method as approved by the Engineer.

B. The stabilized aggregate base course shall be allowed to cure for a period of seven (7) days. During this period the base course shall be closed to all traffic. Any portion of the base course seal coat that is damaged shall be repaired at no additional cost to the City.

3.13 MOISTURE AND DUST CONTROL AGENTS

When specified in the Contract Documents or as directed by the Engineer, calcium or magnesium chloride shall be added at the plant or applied to the surface of the graded aggregate, bank run gravel, or sand aggregate base at the project site. Calcium chloride shall be applied at the rate of one (1) lb/yd^2. Magnesium chloride shall be applied at the rate of one (1) lb/yd^2 or as a solution at the rate of one-half (1/2) gal/yd^2.

3.14 MAINTENANCE

During Construction and after completion of the base course, the base shall be maintained by the Contractor until the surface course is placed. Unacceptable Work that cannot be repaired shall be replaced for the full depth of the base at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all aggregate, furnishing, hauling, placing, curing, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Graded aggregate base course, graded aggregate base course stabilized with cement, bank run gravel base course, and sand aggregate base course will be measured and paid for at the Contract Unit Price per square yard.

C. Surface area measurements will be based on the width of the base as specified in the Contract Documents and the actual length measured along the centerline of the base surface.

D. The temporary graded aggregate base wedge constructed for maintaining the four to one (4:1) or flatter slope, compaction, and removal of the material, will not be measured but the cost will be incidental to the graded aggregate base course item.

E. The portland cement stabilizing agent and the emulsified asphalt for seal coat will not be measured but the cost will be incidental to the graded aggregate base course stabilized with cement item.

F. Bank Run Gravel Base: Material manipulation or addition of chemical additives will not be measured but the cost will be incidental to the bank run gravel base course item.

G. Calcium or magnesium chloride will be measured and paid for at the Contract Unit Price per square yard or if specified in the Contract Documents, at the Contract Unit Price per ton.

32 11 23.11 AGGREGATE FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of utilizing aggregate for maintenance of traffic within the existing facilities as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Crusher Run Aggregate CR 6. Refer to 32 11 23.10, (Aggregate Base Course).

B. Bank Run Gravel Subbase. Refer to 32 11 23.10, (Aggregate Base Course).

PART 3 EXECUTION

Refer to the applicable portions of 32 11 23.10, (Aggregate Base Course).

PART 4 MEASUREMENT AND PAYMENT

A. Crusher Run Aggregate: CR 6 for maintenance of traffic, bank run gravel subbase for maintenance of traffic, and graded aggregate base for maintenance of traffic will be measured and paid for at the Contract Unit Price per ton. The payment will be full compensation for all aggregate, hauling, placing, compacting, removal, rehandling, reworking, and disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. When aggregate is part of any base or pavement course used for the Construction and maintenance of temporary detours, approaches, crossings and widenings, the item of Work will be measured and paid for in conformance with 32 11 23.10, (Aggregate Base Course).

C. Aggregate for maintenance of traffic when used for temporary and permanent patching at pipe culverts and utilities will not be measured but the cost will be incidental to the pertinent pipe culvert or utility item.

32 11 33 CEMENT TREATED BASE COURSE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing soil-cement base course using a combination of soil and portland cement, uniformly mixed, moistened, compacted, shaped and sealed. Unless otherwise specified in the Contract Documents, the soil, cement and water may be mixed in a plant or mixed in place, at the Contractor's option.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland Cement: The manufacturer shall furnish certification which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certification shall also include:

1. The mill shall report its quality control procedures, and submit a new report whenever there is a procedural change.
2. The mill's control laboratory shall be inspected by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology on their regularly scheduled visits. The Engineer shall be provided with copies of the reports of these inspections along with an account of the action taken to correct cited deficiencies.

B. Records of data accumulated by the quality control procedures shall be produced upon request.

C. A certified document shall accompany each shipment stating that the contents conform to all applicable requirements. Additionally, the document shall show the producer's name, mill location, carrier number, date loaded, weight contained in carrier, silo number, consignee, destination, Contract number, and type of cement. The signature and title of the signer shall be shown on the document.

D. The mill shall, upon request, supply certified chemical and physical test values that can be associated with any sample representing cement drawn from a particular silo on a given date.

E. Acceptance of cement by certification will be terminated if test results differ from mill results by more than the precision limits given in the test method. The acceptance procedure shall then revert to storage testing and approval prior to shipment.

F. Portland cement shall conform to M 85, with the fineness and the time of setting determined in conformance with T 153 and T 131, respectively. Blended hydraulic cement shall conform to M 240, Type I (PM) or a Type IP containing fifteen percent to twenty-five percent (15% to 25%) pozzolan by weight of cement. Maximum loss on ignition shall be

three percent (3.0%) and ground iron blast furnace slag shall not be used for blending. The requirement for a manufacturer's written statement of the chemical composition is waived.

G. Emulsified Asphalts

1. Emulsified asphalts shall conform to M 140 or M 208 with the following exceptions:

a. Cement mixing tests are waived.
b. Grade SS-1 viscosity shall be fifty to four hundred (50 to 400) seconds at seventy-seven degrees (77°) F.
c. Maximum of three percent (3.0%) by volume of oil distillate.
d. The sieve test requirement for field samples shall be a maximum of four-tenths percent (0.4%).

H. Production Plant: Refer to 03 30 43, (Production Plants) and 03 30 53.01, Part 2, (Miscellaneous Structures).

I. Soil: Refer to 31 23 16.12, Part 2, (Select Borrow Excavation).

Capping shall not contain aggregate retained on three inch (3″) sieve, nor more than forty-five percent (45%) retained on a No. 4 sieve.

J. Water shall conform to the pH requirements of T 26, Method B and shall be clear. If questionable quality is suspected, the water shall conform to the limits of the comparison tests with distilled water as specified in T 26. The chloride concentration of water used in mixing and curing of portland cement concrete shall be determined in conformance with D 512 and shall not exceed one thousand (1000) ppm.

PART 3 EXECUTION

3.1 CONSTRUCTION

A. At least thirty (30) days prior to the start of constructing the base course, the Contractor shall submit proposed production plants, location of plants with respect to project site, equipment, and material sources to the Engineer for approval.

B. The Contractor shall protect the subgrade and base against damage from all causes. Any part of the subgrade or base that is damaged shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the City.

3.2 EQUIPMENT

All equipment, including the production plant and on-site equipment, shall be subject to approval by the Engineer. The production plant shall be ready for inspection by the Engineer at least eight (8) hours before the start of Construction operations.

3.3 WEATHER RESTRICTIONS

A. Temperature and Surface Conditions: Soil-cement base course shall be placed only when the ambient air and surface temperature is at least forty degrees (40°) F and rising. Placing material on a frozen subgrade is prohibited.

B. Cold Weather Protection: The completed base shall be protected from freezing during the seven (7) day curing period.

C. Precipitation: Construction during precipitation is prohibited. When precipitation has occurred during the previous twenty-four (24) hours, the Engineer will determine if the subgrade is sufficiently dry. If precipitation occurs during placement, material en route from the plant to the job site may be placed at the Contractor's risk.

3.4 SUBGRADE PREPARATION

The approved subgrade set to final line and grade shall be completed at least five hundred feet (500′) ahead of the base course or as directed by the Engineer before the base course Construction begins. The foundation shall be constructed as specified in 31 24 13.10, (Embankment and Subgrade), 31 23 13, (Subgrade Preparation) and the Contract Documents, and as approved by the Engineer. If traffic, including Construction equipment, is allowed to use the subgrade foundation or preceding layer, it shall be distributed over the entire width of the course to aid in obtaining uniform and thorough compaction. If ruts are formed, they shall be removed by reshaping and recompacting the affected area as specified in 31 24 13.10, (Embankment and Subgrade).

3.5 DESIGN MIX

At least forty-five (45) days prior to the start of constructing the base course, the Contractor shall submit to the Engineer, samples of the soil and portland cement from the proposed material sources. Materials shall be sampled as specified in the materials manual. The Engineer shall determine the exact proportions of soil and portland cement and the optimum moisture content based on these samples. Proportions may be revised during Construction to provide for changing conditions as directed by the Engineer. Plant mixed material shall be sampled at the plant. Mixed in place material shall be sampled from a one hundred feet (100′) long control strip constructed on the site by the Contractor.

3.6 TRANSPORTATION

Mixed materials shall be handled and transported to minimize segregation and loss of moisture. All loads shall be covered in conformance with state laws unless hauling is off road and is approved by the Engineer. Dumping into piles, hauling over the completed base course, and stockpiling of mixed material is prohibited unless approved by the Engineer.

3.7 SPREADING OF PLANT MIX MATERIAL

The approved soil-cement mix shall be uniformly spread over the subgrade, without segregating the coarse and fine particles, in layers of approximately equal thickness, to provide the specified planned depth. Shoulders or berms not less than two feet (2′) wide

shall be built up on each side of the base to the top elevation of each uncompacted layer unless the base is placed against concrete curbs or gutters.

3.8 MIXED IN PLACE CONSTRUCTION

The soil base material shall be pulverized to ensure that, at the completion of moist mixing, one hundred percent (100%) passes a one inch (1″) sieve and a minimum of eighty percent (80%) passes a No. 4 sieve. Moisture content of soil at the time of cement application shall not vary more than two percent (2%) from optimum. Portland cement shall then be spread on the soil at the approved spread rate. The Contractor shall use an accurate scale to verify the spread rate in the presence of the Engineer. The pulverized soil and cement shall then be thoroughly mixed. Immediately after the mixing operation is completed, the water shall be sprayed on the mixture at the approved rate using a pressurized distributor. The soil/cement/water combination shall be mixed until it is uniform, as determined by the Engineer.

3.9 GRADE OR FINISHED SURFACE CONTROL

The surface of the base material shall be brought to line and grade and shaped to the specified spacing of twenty-five feet (25′). The surface material shall be compacted and smoothed over its full width using a smooth faced steel wheeled roller or if rolling is not feasible by mechanical tampers and vibratory compactors as approved by the Engineer. The finished grade shall not deviate more than one-half inch (1/2″) from the established grade.

3.10 FINISHING

The surface of the base material shall be shaped to the required lines, grades and cross section specified in the Contract Documents.

3.11 COMPACTION

A. Immediately after placement, the soil-cement base shall be compacted to a density of not less than one hundred percent (100%) of the maximum density as determined by T 134. In place density shall be measured as specified in Maryland Standard Method of Tests (MSMT) 350. The Contractor shall provide a portland cement concrete compaction block having dimensions eighteen inches by eighteen inches by nine inches (18″ X 18″ X 9″) and weighing at least two hundred (200) lb. One (1), eighteen inch by eighteen inch (18″ X 18″) working face shall have a level broomed surface.

B. At the start of compaction, the moisture in the mixture shall not be more than two (2) percentage points above or below the specified optimum moisture content of the soil-cement mixture. Compaction operations, except on super elevated curves, shall begin at the sides of the course, overlap the shoulder or berm at least one foot (1′) and progress toward the center parallel to the center line of the roadway. Super elevated curve compaction shall begin at the low side of the super elevation and progress toward the high side. The compaction operation shall continue until all compaction marks are eliminated.

3.12 CONSTRUCTION JOINTS

At the end of each day's Construction, a straight transverse Construction joint shall be formed by cutting back into the completed Work to form a vertical face. The base for large, wide areas shall be built in a series of parallel lanes of convenient length and width, complete with longitudinal joints, as approved by the Engineer.

3.13 PROTECTION AND CURING

A. All spreading, compacting and shaping shall be completed within three hours after the mixing water, cement and soil have come in contact. Any section not conforming to these requirements shall be reconstructed as directed by the Engineer. The surface of the base course shall be maintained in a moist condition until the emulsified asphalt is applied. The emulsified asphalt shall be applied by distributing equipment as specified in Part 2, B at the rate of two-tenths (0.2) gal/yd^2. Ponding of the emulsified asphalt shall be avoided. If ponding occurs, the Contractor shall use a sand blotter or an equivalent method as approved by the Engineer.

B. The soil cement base course shall be allowed to cure for a period of seven (7) days. During this period the base course shall be closed to all traffic. Any portion of the base course that is damaged shall be repaired at no additional cost to the City.

3.14 MAINTENANCE

During Construction and after completion of the base course, the base shall be maintained by the Contractor until the surface course is placed. Unacceptable Work that cannot be repaired shall be replaced for the full depth of the base course at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for furnishing, hauling, mixing, placing, compacting, watering, control strip, emulsified asphalt, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Soil-Cement Base Course will be measured and paid for at the Contract Unit Price per square yard.

C. Surface area measurements will be based on the width of the base as specified in the Contract Documents and the actual length measured along the centerline of the base surface.

D. Portland cement for soil-cement base course will be measured and paid for at the Contract Unit Price per ton.

32 12 00 ASPHALT PAVING

32 12 16.13 PLANT MIX ASPHALT PAVEMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing hot mix asphalt (HMA) pavement as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Performance Graded Asphalt Binders and Hot Mix Asphalt

1. Certification: The manufacturer and hauler shall furnish certifications. These certifications shall be documents, which verify that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certifications shall be on the Contractor's, vendor's, or manufacturer's letterhead or approved document and shall be duly signed by a company officer. The certifications shall also include the following:

   a. The manufacturer shall also certify:

      1) Date and time of loading.
      2) Tank or blending system.
      3) Identification of hauling unit.
      4) Binder grade, temperature, and quantity of materials.
      5) Complete certified analysis.
      6) Lot number, if applicable.
      7) Mixing and compaction temperatures when the binder is polymer modified.

   b. The hauler shall also certify:

      1) Identification of hauling unit.
      2) Binder grade and source of last delivery.
      3) The date of the last delivery using this hauling tank and volume of material remaining in the tank at the time of current loading.

2. Performance Graded Asphalt Binders. Performance graded asphalt binders for mixes containing all virgin materials, recycled asphalt pavement materials, or roofing shingles from manufacturing waste shall conform to American Association of State Highway and Transportation Officials (AASHTO) MP1, Table 1, for the specified performance grade. The asphalt binder recovered from the final plant mixed material will be considered rolling thin film oven (RTFO) material and shall conform to AASHTO MP1, Table 1 for the specified performance grade.
3. The performance graded binder shall be preapproved by the City. The Contractor shall submit a certificate of analysis showing conformance with the performance graded binder Specification AASHTO MP1 and the critical cracking temperature as

described in the binder ETG draft, standard practice for determination of low-temperature performance grade (PG) of asphalt binder, for the binders specified in the Contract Documents.

4. The PG binder for HMA mixes shall be achieved by the use of Neat Asphalt with elastomer polymer modifications when needed.

B. Emulsified Asphalts: Emulsified asphalts shall conform to M 140 or M 208 with the following exceptions:

1. Cement mixing tests are waived.
2. Grade SS-1 viscosity shall be fifty to four hundred (50 to 400) seconds at seventy-seven degrees (77°) F.
3. Maximum of three percent (3.0%) by volume of oil distillate.
4. The sieve test requirement for field samples shall be a maximum of four-tenths of a percent (0.4%).

a. Hot Mix Asphalt (HMA): Mixes shall be produced in a plant as specified in paragraph 2.1 J.

1) Aggregates: Aggregates shall conform to the following, and AASHTO MP2 with the exception that the aggregate retained on the four and seventy-five-hundredths (4.75) mm sieve shall be tested for flat and elongated particles in conformance with D 4791. When recycled asphalt pavement is used in an HMA mix as defined in Maryland Standard Method of Tests (MSMT) 412, it shall be considered an aggregate source.

2) Grading requirements are outlined in Tables A and B. Force drying may be used in the preparation of samples for grading tests conducted in the field. Steel slag may be used.

TABLE A – ASPHALT AGGREGATE GRADING REQUIREMENTS, % PASSING

MATERIAL		SIEVE SIZE		
		19.0 mm	**12.5 mm**	**9.5 mm**
HOT MIX ASPHALT SUPERPAVE- 4.75 mm		—	—	100
GAP GRADED HOT MIX ASPHALT- 9.5 mm		100	100	75–90
GAP GRADED HOT MIX ASPHALT-12.5 mm		100	90–99	70–85
GAP GRADED HOT MIX ASPHALT-19.0 mm		100	82–88	60 max
MATERIAL		**SIEVE SIZE**		
		3/4"	**1/2"**	**3/8"**
SLURRY SEAL (SS) AND LATEX MODIFIED SLURRY SEAL (LMSS)	MIX II	—	—	100
	MIX III	—	—	100
CHIP SEAL	7	100	90–100	40–70
SURFACE TREATMENT	8	—	100	85–

Note: HMA Superpave four and seventy-five-hundredths (4.75) mm shall be designed with Equivalent Single Axle Loading (ESAL) ranges of three-tenths (0.3) to less than three (3.0) million.

TABLE B – AGGREGATE PHYSICAL PROPERTY

MATERIAL	SPECIFICATION	TEST METHOD										
		T 90	T 104	T 112	T 113	T 112 & T 113	T 11	T 113	D 4791 (a)	T 96	MSMT 411	T 279
		PI	SODIUM SULFATE SOUND-NESS	CLAY LUMPS AND FRIABLE PARTICLES	CHERT LESS THAN 2.40 SpGr	SUM OF CLAY LUMPS, FRIABLE PARTICLES AND CHERT	MATERIAL FINER THAN NO. 200 SIEVE	COAL AND LIGNITE	FLAT AND ELONGATED (h)	LOS ANGELES ABRASION (LA)	PV (c)	BPN (c)
		% max	% max	% max	% max	% max	% max	% max	% max	% max	min	min
HOT MIX ASPHALT SUPERPAVE— 4.75mm	MP2	NP	12	2.0	3.0	3.0	—	0.5	10	45	5 (b)	—
HOT MIX ASPHALT SUPERPAVE— 9.5, 12.5, & 19.0mm HIGH ESAL	MP2	NP	12	2.0	3.0	3.0	—	0.5	10	45	5 (b)	—
HOT MIX ASPHALT SUPERPAVE— 9.5, 12.5, & 19.0mm LOW ESAL	MP2	NP	12	2.0	3.0	3.0	—	0.5	10	45	5 (b)	—
HOT MIX ASPHALT SUPERPAVE— 9.5, 12.5, & 19.0mm 8PV	MP2	NP	12	2.0	3.0	3.0	—	0.5	10	45	8 (e)	—
HOT MIX ASPHALT SUPERPAVE— 25.0 & 37.5mm	MP2	NP	12	2.0	3.0	3.0	—	0.5	10	45	—	—
GAP GRADED HOT MIX ASPHALT SUPERPAVE — 9.5, 12.5, & 19.0mm	MP2	NP	12	2.0	3.0	3.0	—	0.5	20/5 (g) (i)	30	8 (e)	—
SLURRY SEAL (SS) & LATEX MODIFIED SLURRY SEAL (LMSS)	—	NP	12	—	—	—	—	—	—	—	4 (f)	16
CHIP SEAL SURFACE TREATMENT	M 80, CLASS A	—	—	2.0	3.0	3.0	1.0(d)	0.5	—	45	—	—
CRUSHED GLASS	M 80	—	12	—	—	—	—	—	—	45	—	—

Notes: (a) Dimensional ratio of calipers shall be 5:1. (b) 5.5 when aggregate from no more than two (2) sources are blended. Proportions of blended aggregate shall be determined as specified in MSMT 416. Not applicable for Gap Graded surface mixes or any other surface mix requiring high polish aggregate. (c) Polish Value (PV) and British Pendulum Number (BPN) determined on parent rock. When recycled asphalt pavement (RAP) is used the PV shall be four (4). (d) 1.0 for samples taken at the point of production. Samples taken at any point after shipment shall not have more than one and one half percent (1.5%) finer than No. 200 sieve. (e) PV shall be nine (9) when the aggregate is blended. When carbonate rock is used it shall have a minimum of twenty five percent (25%) insoluble residue retained on the No. 200 sieve. No blending allowed. Dimensional ratio of calipers shall be 3:1/5:1. (h) The test for flat and elongated particles (max/min) shall be conducted on the blend. (i) Test conducted on particles retained on the No. 4 sieve.

TABLE – MIX DESIGN, TEST METHOD T 27

SIEVE SIZE						
4.75 mm	2.36 mm	1.18 mm	600 µm	300 µm	150 µm	75 µm
80–100	36–76	—	—	—	—	2–12
30–50	20–30	—	—	—	—	8–13
28–40	18–30	—	—	—	—	8–11
22–30	14–20	—	—	—	—	9–11
SIEVE SIZE						
No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
90–100	65–90	45–70	30–50	18–30	10–21	5–15
70–95	45–70	28–50	19–34	12–25	7–18	5–15
0–15	0–5	—	—	—	—	—
10–30	0–10	0–5	—	—	—	—

b. Mix Design: The Contractor shall develop a Superpave mix design in conformance with AASHTO PP 28. HMA Superpave mixes shall conform to the specification for Superpave Volumetric Mix Design, AASHTO MP 2, and shall be designed for the Equivalent Single Axle Loading (ESAL) range specified in the Contract Documents.

1) The Contractor may elect to use crushed, recycled asphalt pavement (RAP) material or a maximum of five percent (5%) roofing shingles from manufacturing waste. The allowable percentage and its suitability for use shall be determined in conformance with Maryland Standard Method of Tests 412. When using fifteen percent (15%) or less of RAP, binder viscosity adjustments are not required.
2) The use of RAP may be considered for applications where higher polish value aggregates are required. Approval for use will be on an individual project basis. Documentation of RAP stockpile quality and traceability shall be submitted to the Engineer for approval prior to use.
3) Crushed glass shall not be used in surface mixes. RAP and roofing shingles from manufacturing waste shall not be used in gap-graded mixes, surface mixes requiring high polish aggregate, or mixes requiring elastomer type polymer binder.

c. Mix Design Approval. Documents containing the data from the Contractor's Laboratory study shall be submitted to the Engineer for tentative approval at least two (2) weeks prior to paving operations using City approved AASHTO software, and shall include the following:

1) Mix designation.
2) Source and percentage of aggregate.
3) Source, percentage, and grade of performance graded asphalt binder.
4) Anticipated gradation and proportion of each component aggregate.
5) Combined cold feed grading, extracted grading, or ignited grading.
6) Plant where the HMA mix will be produced.
7) Plant target mixing temperature based on viscosity of 0.22 PAS.
8) Percent passing No. 200 sieve removed by dust collecting system.
9) Ratio of dust to binder material on effective asphalt.
10) Maximum specific gravity at the target binder content.
11) Mix design grading plotted on forty-five-hundredths (0.45) power gradation chart.
12) Tensile strength ratio and worksheets.
13) The gyratory compaction curve for N_{max}.
14) The bulk specific gravity at N_{design} gyrations.
15) The air void content (percent Va) at $N_{initial}$, N_{design}, and N_{max} gyrations.
16) The voids in the mineral aggregate (percent VMA) and the voids filled with asphalt (percent VFA) at N_{design} gyrations (TP4).
17) The slope of the gyratory compaction curve.
18) All consensus and source properties.

a) Coarse aggregate angularity.
b) Flat and elongated.
c) Sand equivalent.
d) Uncompacted void content of fine aggregate.
e) Bulk and apparent specific gravity of coarse and fine aggregate.
f) Absorption of coarse and fine aggregate.

C. Mix designs submitted to the Engineer for approval shall be accompanied by a quantity of job mix formula aggregate and appropriate amount of required PG binder for ignition oven calibration. If previous Construction or performance experience has shown the proposed mix design to be unsatisfactory, the Engineer may require the Contractor to submit a more suitable design.

D. If the Contractor proposes to change the source of aggregate used in the mix, a revised mix design shall be submitted with the information required above and in paragraph 2.1 E. The conditions set forth above relative to initial submission shall apply. If a change in the performance grade binder source becomes necessary, a stripping test shall be conducted in conformance with Maryland Standard Method of Tests 410, prior to approval. The City may require an antistripping additive test in conformance with D 4867 before giving the final approval.

E. Field Verification of Mix Design. After receiving the tentative approval for the mix design from the Engineer, the Contractor shall conduct a field verification of the mix at the beginning of production in each plant. Field verification shall be performed by the certified personnel as specified in the verification evaluation below. The verification samples shall be prepared as specified in PP28. The Contractor shall notify the Engineer at least two (2) Working days in advance of the scheduled verification.

F. Verification Evaluation.

1. Initial verification shall consist of four (4) samples tested for the parameters listed in Maryland Standard Method of Tests 730, Table 3. These samples shall be randomly drawn from the first day's production. If the first day of production is less than one thousand (1000) tons, the Contractor may choose to spread verification testing over the number of days needed to accumulate one thousand (1000) tons. The verification testing shall be completed on the day when production has reached the one thousand (1000) tons. The Contractor shall evaluate the verification tests results as specified in Maryland Standard Method of Tests 730. All tonnage up to and including the final day of verification will not be subject to a price adjustment if individual test data is within the allowable control limits specified in Table C.
2. If the mix produced by the plant conforms to the parameters listed in Maryland Standard Method of Tests 730, Table 3 with the percent within Specification limit (PWSL) a minimum of eighty five (85), production may proceed without any changes. If the Contractor has submitted mixes with identical aggregate combinations and differing asphalt contents associated with changes in ESAL loads, verification will be limited to volumetric analysis at the Engineer's discretion.
3. If the mix produced by the plant does not conform to the parameters listed in Maryland Standard Method of Tests 730, Table 3 with PWSL a minimum of eighty-five (85), then an adjustment to the asphalt content or gradation may be made to bring the mix design requirements within acceptable levels.

Permissible adjustment limitations between the approved Mix Design and Adjusted Mix Design are as follows:

TEST PROPERTY	PERMISSIBLE ADJUSTMENT % (*)
Larger than 1/2 inch (12.5 mm) sieve	± 5
1/2 inch (12.5 mm) thru No. 4 (4.75 mm) sieves	± 4
No. 8 (2.36 mm) thru No. 100 (1.50 μm) sieves	± 3
No. 200 (75 μm) sieve	± 1.0
Binder Content	± 0.20

*The permissible adjustment for all mixes shall establish a job mix formula having targets outside the restricted zone. Additionally, Superpave mixes shall be within control points.

4. When an adjustment is made to the mix design, a second verification shall be performed to ensure that the modified mix conforms to all design requirements. The time and tonnage limitations shall be as specified in letter "a" above. Material produced during this verification will be subject to a price adjustment if it does not conform to Specifications.
5. If the adjusted mix conforms to the PWSL, production may proceed. If the mix does not conform to these requirements, production for the mix shall be suspended and a new mix design shall be submitted to the Engineer for approval. The new mix shall be designed as specified in Maryland Standard Method of Tests 412 or AASHTO PP28.
6. Subsequent designs submitted due to nonconformance will be subjected to the price adjustment during the required field verifications. If the mix does not conform to letter "b" above during the initial verification, production for the mix shall be suspended until corrective action is taken as approved by the Engineer.

G. Antistripping Additives. HMA shall have a minimum Tensile Strength Ratio (TSR) of eighty-five-hundredths (0.85) when tested in conformance with D 4867. The freeze-thaw conditioning cycle is required. HMA mixes not conforming to the minimum TSR requirement shall include an antistripping additive.

1. When an antistripping additive is needed, the exact quantity shall be determined by the producer in conformance with D 4867 based on a minimum TSR of 0.85.
2. When a heat stable antistripping additive is used, the minimum dosage rate shall be two-tenths percent (0.20%) of the total weight of asphalt. The additive shall be introduced at the plant by line blending, metering, or otherwise measuring to ensure accurate proportioning and thorough mixing.
3. When hydrated lime is used, it shall be added in slurry form at the rate of one percent to one and one-half percent (1.0% to 1.5%) by weight of total aggregate. The hydrated lime shall conform to C 1097. Lime slurry shall be sprayed uniformly on the damp, cold aggregate on the feed belt prior to entry into the HMA plant dryer.
4. Plant control and acceptance of the mix shall be based on Maryland Standard Method of Tests 410 with respect to its stripping potential.

H. Plant Control. The following tolerances shall apply:

TABLE C – MIX TOLERANCES

PHYSICAL PROPERTY	TOLERANCE (b)
Passing No. 4 (4.75 mm) sieve and larger, %	± 7
Passing No. 8 (2.36 mm) thru No. 100 (150 μm) sieve, %	± 4
Passing No. 200 (75 μm) sieve, %	± 2
Asphalt content, %	± 0.4
Ratio of dust to binder material	0.6 to 1.6 (a)
Mix temperature leaving plant versus mix design temperature	± 25
Deviation of maximum specific gravity per lot versus design	± 0.030
Voids, total mix, (VTM), %	3.5 ± 1.2
Voids, total mix, 4.75 mm mix (VTM), %	3 ± 2
Voids in mineral aggregate, (VMA), %	± 1.2 from design target
Voids filled asphalt (VFA), %	Within spec
Bulk specific gravity, G_{mb}, %	± 0.022
G_{mb} at N_{max}, %	+ 0.5

Note: (a) Not applicable to four and seventy-five-hundredths (4.75) mm.
Note: (b) For mixes other than Gap Graded HMA.

Percent Within Specification Limit (PWSL) computations shall be performed for maximum specific gravity, voids in the total mix, voids in the mineral aggregate, and voids filled with asphalt. This computation shall be performed as specified in paragraph 4.3 using the moving average of the last three (3) consecutive test values for each parameter. If the PWSL for the three (3) test values fall below eighty-five (85), corrective action shall be taken to bring the PWSL to at least eighty-five (85). If the PWSL drops below sixty-eight (68), production shall be suspended until corrective action is taken as approved by the Engineer.

I. Crack Filler. Joint sealer and crack filler shall conform to D 3405 as modified by Maryland Standard Method of Tests 404. The manufacturer shall furnish certification. This certification shall be a document, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Manufacturer's recommendations regarding heating and pouring temperatures will be used when testing these materials. If a range of temperatures is recommended, the midpoint will be used as the pour point.

1. Silicone Joint Sealer and Crack Filler

   a. Silicone joint sealer and crack filler shall be low modulus, one (1) component compound, which may or may not, require a primer for bonding to concrete. If a primer is required, it shall be as recommended by the sealant manufacturer and shall be placed on the joint faces following the insertion of the backup material.

b. Silicone material, when tested at seventy-three degrees (73°) plus or minus three degrees (± 3°) F and forty-five to fifty-five (45 to 55) relative humidity, shall conform to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Shore A Hardness, at 7 days	D 2240	10–25
Tensile Strength at 50 % Elongation, psi max	D 412 Die C	45
Elongation, % min	D 412 , Die C	700
Adhesion in Peel, lb/in. min	Federal Spec TT-S-0230	20
Flow, 0.01 inch max	T 187	0.3
Tack-Free Time, minutes	D 2377	20–75

c. Each container of silicone sealer and crack filler shall have a minimum shelf life of six (6) months. Material more than six (6) months old shall be retested.

J. Production Plant. Refer to 30 30 43, (Production Plants), for Specifications applicable to all batching and proportioning plants.

K. Hot Mix Asphalt (HMA) Plants.

1. All plants shall conform to M 156, and be equipped with automatic batching and recording of batching, except as modified in 30 30 43 (Production Plants) and paragraph 2.1, J.

PART 3 EXECUTION

3.1 GENERAL

A. Quality Control Plan. At least thirty (30) days prior to the placement of any HMA pavement, the Contractor shall submit, in writing, a plant quality control plan to the Engineer and a field quality control plan to the Engineer for approval. The quality control plans shall contain a statistically based procedure of random sampling and shall show how the Contractor proposes to control the equipment, materials, production and paving operations to ensure conformance with these Specifications. A master plant quality control plan may be submitted for this prior approval. If a master plant quality control plan is submitted and approved, an addendum shall be submitted for each specific Contract.

1. The plan shall contain production plants, location of plants with respect to the project site, personnel qualifications, inspection and record keeping methods, and minimum frequencies of sampling and testing as specified in Maryland Standard Method of Tests 730, Table 3. The plan shall also detail when and how corrective action will be taken for unsatisfactory Construction practices and deviations from the material Specifications. Additionally, the plan shall include a quality control plan for the plant, which addresses all elements necessary for quality control.

B. Plan Administrator and Certified Technicians. The quality control plan shall designate a plan administrator. The plan administrator shall have full authority to institute any actions

necessary for the successful operation of the plan. The plan administrator may supervise the quality control plan on more than one project if that person can be in contact with the job site within one (1) hour after being notified of a problem.

1. The quality control plan shall also designate a certified plant control technician, field control technician and certified materials tester, if used, as specified in Maryland Standard Method of Tests 731.

C. Records. The Contractor shall maintain complete records of sampling, testing, actions taken to correct problems and quality control inspection results and shall make them available to the Engineer upon request. Copies of the reports shall be provided when requested by the Engineer.

1. Linear control charts shall be maintained by the Contractor. Control charts shall be maintained in the quality control Laboratory in a manner satisfactory to the Engineer and shall be current. As a minimum, the control charts shall identify the mix design number, each test result and the upper and lower Specification limits applicable to each test.

D. Acceptance. The City will provide acceptance by:

1. Conducting independent verification sampling and testing separate from the Contractor/producer.
2. Periodically observing tests performed by the producer.
3. Monitoring required control charts.
4. Directing the producer to take additional samples at any time and location.
5. Monitoring the Contractor's conformance with the quality control plan.
6. Evaluating quality control sampling and testing by an independent assurance program.

3.2 EQUIPMENT

A. All equipment, including the production plant and paving equipment, shall be subject to approval by the Engineer. The plant shall be ready for inspection by the Engineer at least forty-eight (48) hours prior to the start of Construction operations.

B. Hauling Units: Refer to paragraph 2.1 J. Due regard shall be given to the safety and convenience of the public while applying and maintaining the tack coat. Provisions shall be made to minimize hauling trucks from tracking tack coat onto the adjacent pavement.

C. Pavers: Paver Units will be inspected and approved by the Engineer based upon the manufacturer's specification manual (copy to be provided by the Contractor). The paver shall be a self-contained, self-propelled unit capable of spreading the mixture true to line, grade and cross slope. The paver shall be equipped with a screed or strike off assembly that will produce a finished surface of the required smoothness and texture without tearing, shoving or gouging the mixture. The paver shall have automatic controls for transverse slope and grade. Controls shall be capable of sensing grade from an outside reference line or ski and sensing the transverse slope of the screed to maintain the required grade and transverse slope within plus or minus one tenth (0.1) of the required slope percentage.

1. Manual operation will be permitted in the Construction of irregularly shaped and minor areas or where directed by the Engineer.
2. Whenever a breakdown or malfunction of any automatic control occurs, the equipment may be operated manually for the remainder of the workday as directed by the Engineer.
3. Reference lines or other suitable markings to control the horizontal alignment shall be provided by the Contractor, subject to the approval of the Engineer.

D. Rollers: Rollers shall be self-propelled, reversible, and steel wheeled or pneumatic tired. Rollers may be vibratory or non-vibratory, and they may be operated in the vibratory mode as long as the Engineer determines that the roller is not cracking or damaging the aggregate in the mix. Rollers shall not be used in the vibratory mode on bridge decks. Pneumatic tire rollers shall have multiple tires of equal size with smooth tread. Wheels shall be arranged to oscillate in pairs, or they may be individually sprung. Tires shall be uniformly inflated at the operating pressure approved by the Engineer. The Contractor shall furnish the Engineer a manufacturer's table showing this data. The difference in tire pressure between any two (2) tires shall not be greater than five (5) psi. The Contractor shall provide a means for checking the tire pressure on the job at all times.

3.3 WEATHER RESTRICTIONS

HMA material shall only be placed on roadway surfaces when the ambient air and surface temperature is at least forty degrees (40°) F and rising for surface mixes and at least thirty-two degrees (32°) F and rising for base mixes. The pavement surfaces shall be clean and dry and approved by the Engineer before HMA paving begins. Placing HMA material on a frozen graded aggregate base is prohibited. When weather conditions differ from these limits, material en route from the plant to the job site may be used at the Contractor's risk. If placement of the material is stopped by the Engineer, all material en route shall be wasted at no additional cost to the City.

3.4 FOUNDATION PREPARATION

Prior to placement of paving material, the foundation shall be constructed as specified in the Contract Documents and approved by the Engineer. When paving over existing pavement, all excess crack filling or patch material shall be removed and all spalls and potholes shall be cleaned, tack coated, filled and tamped with HMA before placement. Manholes, valve boxes, inlets, and other appurtenances within the area to be paved shall be adjusted to grade as directed by the Engineer.

3.5 TACK COAT

Prior to application of the tack coat, the surface shall be cleaned of all loose and foreign materials. The tack coat shall be uniformly applied to the surface by full circulation spray bars that are laterally and vertically adjustable and provide triple fanning and overlapping action so that the resulting coating shall be residual asphalt applied at a rate of one-hundredth to five-hundredths (0.01 to 0.05) gal/yd^2 as directed by the Engineer.

3.6 HOT MIX ASPHALT PLACEMENT

HMA shall be placed by the paver. Delivery of the mixture by the hauling units and placement shall be continuous. The temperature of the mixture shall be a minimum of

two-hundred twenty-five degrees (225°) F at the time of placement. Broadcasting of loose mixture over the new surface is prohibited.

3.7 COMPACTION

A. Immediately following placement of the HMA, the mixture shall be compacted by rolling to in place density of ninety-two percent to ninety seven percent (92.0% to 97.0%) of the maximum density. In place compaction shall be completed before the mixture cools below one-hundred eighty-five degrees (185°) F, as determined by a probe type surface thermometer, supplied by the Contractor and approved by the Engineer. Price adjustment due to noncompliance with the required density will be as specified in Part 4.3. Probe type surface thermometer shall remain the property of the Contractor at the completion of the project

B. Rolling shall consist of six (6) separate operations in the following sequence:

1. Transverse joint.
2. Longitudinal joint.
3. Edges.
4. Initial breakdown rolling.
5. Second or intermediate rolling.
6. Finish rolling.

C. Steel wheel rollers shall be used for the first rolling of all joints and edges, the initial breakdown rolling, and the finish rolling.

D. Rollers shall start at the sides and proceed longitudinally toward the center of the pavement, except on super-elevated curves. The rolling shall begin at the low side and progress toward the high side. Successive trips of the roller shall overlap by at least half the width of the roller, and alternate trips shall not end at the same point. When base widening is too narrow to permit the use of conventional rollers, a power driven trench roller shall be used. When the trench must be excavated wider than the proposed width of the widening, an earth berm or shoulder shall be formed against the loose HMA as soon as it is placed. The two (2) materials shall be rolled and compacted simultaneously. Roller marks shall not be visible after rolling operations.

E. After rolling is completed, no traffic of any kind will be permitted on the pavement until the pavement has cooled to less than one-hundred forty degrees (140°) F or as directed by the Engineer.

3.8 JOINTS

A. Both longitudinal and transverse joints in successive courses shall be staggered so that one is not above the other. Transverse joints shall be staggered by the length of the paver. Longitudinal joints shall be staggered a minimum of six inches (6″) and shall be arranged so that the longitudinal joint in the top course shall be within six inches (6″) of the line dividing the traffic lanes.

B. Joints shall be constructed to provide a continuous bond between the old and new surfaces.

C. Joints shall be coated with tack coat as directed by the Engineer. When placing a surface course, the edge of the existing pavement shall be cut back for its full depth at transverse joints to expose a fresh surface which shall be coated with tack coat material as directed by the Engineer. Before placing the mixture against curbs, gutters, headers, manholes, etc., all contact surfaces shall be coated with tack coat.

3.9 EDGE DROPOFF

Where HMA paving is being applied to highways carrying traffic, all pavement courses exceeding two and one-half inches (2-1/2″) in depth shall be matched with the abutting lane or shoulder on the same working day. Where pavement courses of two and one-half inches (2-1/2″) or less are placed, the Contractor shall have the option of paving the abutting lane or shoulder on alternate days. The abutting lane or shoulder shall be paved regardless of the depth of pavement course prior to weekends and temporary shutdowns. When uneven pavement joints exist, the Contractor shall provide advance warning traffic control devices in conformance with the Contract Documents.

3.10 TIE-IN

A. Where HMA paving is being applied to the traveled way carrying traffic, the Contractor shall construct a temporary tie-in a minimum of four feet (4′) in length for each one inch (1″) of pavement depth before traffic is allowed to cross the transverse joint.

B. The final tie-in shall include the removal of a transverse portion of the existing pavement to a depth so the design thickness of the final surface course is maintained. The length of the final tie-in shall be equal to the posted speed per one inch (1″) depth of the design thickness of the final course with a minimum length of twenty-five feet (25′) per one inch (1″) depth and a maximum length of fifty feet (50′) per one inch (1″) depth.

3.11 SAMPLING AND TESTING FOR DENSITY

A. Density testing shall be performed before allowing traffic or Construction equipment on the in place material and before placement of the next layer.

1. Compaction for Quality Control. A lot shall not exceed one thousand (1000) tons. A sublot shall not exceed two hundred (200) tons. Five (5) consecutive two hundred (200) ton sublots shall equal one (1) lot. A lot may contain only one (1) sublot that is less than two hundred (200) tons.
2. On any paving day when production does not end in a multiple of one thousand (1000) tons, the remaining fraction shall be considered another lot. A paving day shall begin with a new lot and sublots. Control strips shall be divided into five (5) equal sublots.
3. On Contracts requiring less than five hundred (500) tons of HMA or when HMA is used in nontraffic areas or on bridge decks, acceptance will be determined by the use of a thin layer nuclear density gauge, when tested in conformance with the manufacturer's recommendations. When the HMA courses are compacted to one inch (1″) or less, a control strip shall be constructed on the first day of paving. Readings shall be taken with a thin layer nuclear density gauge to determine roller patterns and the number of coverage's needed to obtain optimum density. Optimum density is defined as when the average density does not change by more than one percent (1.0%) between successive coverage's of a four hundred (400′) to five hundred (500') ft area. This optimum density shall be used to determine

HMA acceptance after approval by the Engineer. Any lot average two percent (2.0%) or more below optimum density shall require a new control strip be constructed and tested before paving continues.

4. The Contractor may use the core or the combined nuclear/core method of testing on Contracts requiring five hundred (500) tons or more.
5. The Contractor shall secure samples and perform tests as follows:

    a. Core Method. When the core method is used, the Contractor shall take samples as specified in Maryland Standard Method of Tests 451, Method B, for each sublot of material placed. Core sample locations will be randomly determined by the Engineer in conformance with Maryland Standard Method of Tests 418.

6. Two (2) core samples shall be taken from each sublot no later than the next day after compaction. The size diameter cores shall be four inch or six inch (4″ or 6″) cores for nine and five-tenths (9.5) mm, twelve and five-tenths (12.5) mm, and nineteen (19.0) mm mixes; and six inch (6″) cores for twenty-five (25.0) mm and Thirty-seven and five-tenths (37.5) mm mixes. These cores shall represent the day's production and shall be taken prior to placement of the next layer.
7. Core samples shall be tested in conformance with Maryland Standard Method of Tests 452. The specific gravity of the samples shall be expressed as a percentage of the maximum specific gravity determined for each lot of material. The in place density of each mixture in each lot shall be ninety-two percent to ninety-seven percent (92.0% to 97.0%). The two (2) core results from each sublot shall be averaged and compliance will be determined on the basis of all sublots tested for each material. Results shall be made available by the Contractor no later than the following workday.

    a. Nuclear/Core Method. The nuclear gauge shall be calibrated in conformance with Maryland Standard Method of Tests 417. A daily validation and standard count shall be performed as specified in the manufacturer's recommendations. A log of these validations and counts shall be with the gauge at all times.

8. Two (2), one (1) minute special calibration nuclear tests shall be conducted on each sublot as specified in Maryland Standard Method of Tests 418 no later than the next workday after compaction. A special calibration nuclear test is defined as an average of a minimum of two (2) special calibration readings taken at the same location after rotating the gauge one-hundred eighty degrees (180). Two (2) tests per sublot; a minimum of four (4) readings (two (2) tests X two (2) readings/test = 4) shall be taken. Likewise, a one thousand (1000) ton lot shall have a minimum of twenty (20) readings (five (5) sublots X two (2) tests/sublot X two (2) readings/test = 20).
9. The results of the two (2) nuclear tests in each sublot shall be averaged and conformance will be determined on the basis of all sublots tested for each material.
10. Three (3) cores for each lot of material shall be sampled; one (1) at each of three (3) different nuclear test locations determined by the Engineer. The average of the three (3) core results and the average of the three (3) corresponding nuclear tests shall be within three (3.0) lb/ft^3. When the difference between nuclear test results and core test results is greater than three (3.0) lb/ft^3, the Contractor shall use the core method of testing. The Contractor may return to the nuclear/core method of testing when all calibration criteria are met. If the Contractor's nuclear test results

again fail to conform to the three (3.0) lb/ft^3 maximum requirement, the core method of density determination shall be used for the remainder of the project.

B. Acceptance Testing.

1. Core Method. Acceptance testing will be performed on a minimum of three (3) cores per six thousand (6000) tons when the core method of control is used. If the specific gravity difference on each of the three (3) cores is within three one-hundredths (0.030), all the lots will be evaluated individually using the test results of quality control samples as specified in 4.3. If the difference is greater than three one-hundredths (0.030), the Engineer will conduct tests on the remainder of the quality control samples since the last acceptance and all the lots will be evaluated individually using the Engineer's test results.
2. Nuclear/Core Method. When the nuclear/core method is used, the Engineer will witness the Contractor's testing and coring and will perform acceptance testing on three (3) verification cores from any one (1) lot since the last acceptance. If the density difference between the average of three (3) verification cores and the average of three (3) corresponding nuclear tests is within three (3.0) lb/ft3, all the lots will be evaluated individually using nuclear quality control test results as specified in 4.3.
3. If the difference is greater than three (3.0) lb/ft^3, the Engineer will test the remainder of the verification cores since the last acceptance. All lots will be evaluated for the three (3.0) lb/ft^3 difference. Lots not conforming to the three (3.0) lb/ft^3 differences will be evaluated individually as specified in 4.3 using verification core test results. Lots conforming to the three (3.0) lb/ft^3 differences will be evaluated individually.

3.12 CONTROL STRIP

A. The Contractor may opt to construct a control strip for guidance in determining roller patterns to achieve optimum density. When a control strip is constructed, it shall be placed on the first workday in which HMA is placed and shall be between four hundred feet to five hundred feet (400′ and 500′) in length. Based on the Contractor's evaluation of the initial control strip, paving may continue at the Contractor's risk.

B. The Contractor will not be assessed a density pay adjustment for the amount of material required for Construction of the control strips. Should the removal of any control strip be necessary, it shall be removed by the Contractor at no additional cost to the City.

C. The Engineer may require the Contractor to construct a control strip any time during placement of HMA based on the evaluation of compaction results.

3.13 PAVEMENT SURFACE CHECKS

A. The Contractor shall have available, at all times, a ten feet (10′) straightedge approved by the Engineer. After final compaction of each course, the surface of each pavement course shall be true to the established line and grade and shall be sufficiently smooth so that when tested with a ten feet (10′) straightedge placed upon the surface parallel with the center line, the surface shall not deviate more than one-eighth inch (1/8″). The transverse slope of the finished surface of each course when tested with a ten feet (10′) straightedge placed perpendicular to the center line, the surface shall not deviate more than three-sixteenths inch (3/16″).

B. Transverse joints on each course shall be checked with a ten feet (10') straightedge immediately after the initial rolling. If the surface of each course varies more than one-eighth inch (1/8″) from true, the Contractor shall make immediate corrections acceptable to the Engineer so that the finished joint surface shall comply.

3.14 CURBS, GUTTERS, ETC.

Where permanent curbs, gutters, edges, and other supports are planned, they shall be constructed and backfilled prior to placing the HMA, which shall then be placed and compacted against them.

3.15 SHOULDERS

Shoulders abutting the HMA surface course of any two (2) lane pavement that is being used by traffic shall be completed as soon as possible after completion of the surface course on that lane. Shoulder Construction shall be as specified in the applicable portions of the Specifications and the Contact Documents.

3.16 PAVEMENT PROFILE

Refer to the pavement surface profile requirements specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Hot mix asphalt pavement will be measured and paid for at the Contract Unit Price per ton. The payment will be full compensation for furnishing, hauling, placing all materials including antistripping additive, tack coat, control strip, pot hole and spall repairs, setting of lines and grades where specified, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Placement and removal of the temporary tie-in where hot mix asphalt is being applied to the traveled way carrying traffic will not be measured but the cost will be incidental to the pertinent hot mix asphalt item.

C. Removal of the existing pavement or structure for the final tie-in will be measured and paid for at the Contract Unit Price for the pertinent items used. The hot mix asphalt for the final tie-in will be measured and paid for at the Contract Unit Price for pertinent hot mix asphalt item.

D. Adjustment of existing visible manholes, valve boxes, inlets or other structures will not be measured but the cost will be incidental to the hot mix asphalt item.

E. Adjustment of existing manholes, valve boxes, inlets or other Structures that are encountered below the existing grade will be considered for payment in conformance the Contract Documents.

F. Removal of existing raised pavement markers will not be measured but the cost will be incidental to the hot mix asphalt item.

G. Removal of existing raised pavement markers that are encountered below the existing pavement will be considered for payment in conformance with the Contract Documents.

4.2 PRICE ADJUSTMENT FOR ASPHALT BINDER

A. An adjustment will be made to the final Contract Unit Price of Hot Mix Asphalt if the price of asphalt binder fluctuates significantly from the prevailing price as quoted in the Contract Documents to the date of placement. This includes HMA patching material converted to tons. The Contract Unit Price will be adjusted by the amount of fluctuation above five percent (5%) for Contracts scheduled to be paved during more than one Construction season or having an estimated mix quantity of ten thousand (10,000) tons or more. For Contracts completed within one Construction season and having an estimated mix quantity of less than ten thousand (10,000) tons, the adjustment will be based upon the amount of fluctuation above fifteen percent (15%). Only the differential percent change beyond the above noted five and fifteen percent (5% and 15%) will be used.

B. For the purpose of making these calculations, a monthly price index will be maintained by the City. This index will be the average F.O.B. selling price of asphalt binder at the supplier's terminal in the State of Maryland.

C. The adjusted Contract Unit Price of hot mix asphalt will be computed monthly by using the following formula:

$$F = (PP - Pb)/ Pb \times 100$$

where:

F	=	percent price increase/decrease of asphalt binder.
PP	=	index price of asphalt binder per ton at placement date, and
Pb	=	prevailing index price of asphalt binder per ton as specified in the Invitation for Bids.

Adjusted Contract Unit Price due Contractor when price of asphalt binder increases:

$$A = B + (D \times T \times Pb)$$

Adjusted Contract Unit Price due City when price of asphalt binder decreases:

$$A = B - (D \times T \times Pb)$$

where:

A	=	Adjusted Contract Unit Price per ton of Hot Mix Asphalt.
B	=	Contract Unit Price per ton of Hot Mix Asphalt.
D	=	Differential percentage expressed as a decimal (F – five percent (5%) or F – fifteen percent (15%) as defined above).
T	=	Design target asphalt content expressed as a decimal, and
Pb	=	Prevailing index price of asphalt binder per ton as specified in the Invitation for Bids.

4.3 PRICE ADJUSTMENT FOR HOT MIX ASPHALT PROPERTIES AND PAVEMENT DENSITY

A. A price adjustment may be made as follows, when the hot mix asphalt properties or pavement density does not conform to Specifications:

1. In the event the Engineer finds the materials or the finished product in which the materials are used or the Work performed are not in reasonably close conformity with the Contract requirements and have resulted in an inferior or unsatisfactory

product, the Work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

2. In the event the Engineer finds the materials or the finished product in which the materials are used are not in conformity with the Contract requirements but that acceptable Work has been produced, the Engineer shall then make a determination if the Work shall be accepted. In this event, the Engineer will document the basis of acceptance by a change order, which will provide for an appropriate adjustment in the Contract Price. Any action taken pursuant to this paragraph may not result in an increase of the Contract Price.

3. The Contract Unit Price will be adjusted in conformance with these procedures. Acceptance and payment factors of specified mixes will be based on density, binder content and gradation. A pay factor for density and a composite pay factor for binder content and gradation will be computed using the quality level analysis—standard deviation method specified in Maryland Standard Method of Tests 730 to determine the total estimated percent of the lot that is within Specification limits. The lot payment for density and the lot payment for binder content, and gradation shall be computed as: Lot Payment = (Contract Unit Price) X (Pay Factor) X (Tonnage).

B. A lot containing material with a pay factor of less than one (1.0) may be accepted at the reduced pay factor, provided the pay factor for density and the composite pay factor for binder content and grading are both at least seventy-five-hundredths (0.75) and there are no isolated defects identified by the Engineer. A lot containing material not conforming to the Specifications may be terminated by the Engineer, and the material in the shortened lot paid for at the reduced pay factor or the Engineer may order removal of the nonconforming material. A lot containing nonconforming material that fails to obtain at least a seventy-five-hundredths (0.75) pay factor for density or a seventy-five-hundredths (0.75) composite pay factor for binder content and gradation, will be rejected and shall be replaced at no additional cost to the City.

C. If less than three (3) samples have been obtained at the time of the verification sampling or at the time a lot is terminated, the material in the shortened lot will be considered a part of the previous lot, or will be accepted based on the individual test data at the Engineer's discretion.

4.4 CONTROL STRIP PRICE ADJUSTMENT

The cost of the control strip, if constructed, will not be measured but will be incidental to the pertinent hot mix asphalt item.

32 12 16.14 GAP-GRADED HOT MIX ASPHALT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the placement of a gap-graded hot mix asphalt surface (GGHMA) as specified in the Contract Documents. GGHMA shall conform to 32 12 16.13, (Plant Mix Asphalt Pavement), except as specified herein.

PART 2 PRODUCTS

2.1 MATERIALS

A. Gap-Graded Hot Mix Asphalt: Gap-Graded hot mix asphalt shall conform to the following:

1. Aggregates. Refer to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).
2. Mix Design Approval. Refer to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).
3. Mix Design. Refer to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement) and the following table:

MIX TOLERANCES

PHYSICAL PROPERTIES	MIX DESIGN	PLANT CONTROL
VCA* Mix, %	Less than VCA_{drc}	Less than VCA_{drc}
VMA, %	18.0 min.	17.0 min.
VTM, %	3.5	± 1.2
N_{design} Gyrations	100	—
AC% by volume	6.5 min.	± 0.4
Draindown, % max	0.3	—
Stabilizer, by weight of total mix, %	0.2–0.4	± 0.1

*VCA – voids in coarse aggregate.

4. Performance Graded Binder. As specified in the Contract Documents, 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement) and the following table:

TABLE BASED ON MINIMUM ASPHALT BINDER CONTENT OF 6.5 BY VOLUME

Combined Aggregate Bulk Specific Gravity	Minimum Asphalt Content %	Rounded Minimum Asphalt Content, %
2.40	7.38	7.4
2.45	7.24	7.2
2.50	7.11	7.1
2.55	6.98	7.0
2.60	6.85	6.8
2.65	6.73	6.7
2.70	6.61	6.6
2.75	6.50	6.5
2.80	6.39	6.4
2.85	6.29	6.3
2.90	6.19	6.2
2.95	6.09	6.1
3.00	5.99	6.0

Note: The above table shall be used to establish minimum asphalt binder content requirements based on the combined aggregate bulk specific gravity.

Minimum Asphalt Content = $16.13 / (0.1613 + 0.8434\ G_{sb})$

Gsb = bulk specific gravity of combined aggregate

5. Stabilizer. GGHMA shall incorporate a stabilizer selected from a source previously approved by the City.
6. Stabilizer Supply System. A separate system for feeding shall be used to proportion the required amount into the mixture so that uniform distribution is obtained.
7. When a batch plant is used, the stabilizer shall be added to the aggregate in the weigh hopper and both dry and wet mixing times shall be increased. The stabilizer shall be uniformly distributed prior to the addition of asphalt cement into the mixture. The plant shall be interlocked so that asphalt cannot be added until the stabilizer has been introduced into the mix.
8. When a drum plant is used, the stabilizer shall be added to the mixture in a manner that prevents the stabilizer from becoming entangled in the exhaust system.
9. The stabilizer supply system shall include low level and no-flow indicators, and a printout of the status of feed rate in lb/minute and shall have a sixty (60) second plant shut down function for no-flow occurrences.
10. The stabilizer supply line shall include a section of transparent pipe for observing consistency of flow or feed.
11. All stabilizer addition systems shall be as approved by the Engineer.
12. Anti-stripping Additives. Refer to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

B. Production Plant: shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement).

PART 3 EXECUTION

3.1 DEMONSTRATION

Before proceeding with the actual Work, the Contractor shall demonstrate to the Engineer that a satisfactory mix can be produced, placed, and the compactive effort determined. A minimum of one hundred (100) tons of GGHMA shall be placed outside the project limits for the demonstration. A material transfer vehicle may be used as part of the paving operations.

3.2 HAULING UNITS

A. Dry soap powder, as approved by the Engineer, may be used with the release agent specified in 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement). Truck beds shall be raised to drain excess water before being loaded with GGHMA.

B. A light dusting of No. 10 aggregate coated with one percent (1%) asphalt may be used in lieu of the liquid release agent.

C. The time between plant mixing and shipment shall not exceed one (1) hour (storage time may vary depending upon gradation, type of binder and/or stabilizer. Storage material shall consistently have results of no less quality than mixtures discharged directly into hauling vehicles). Each load shall be completely covered with a full tarp extending a minimum of six inches (6″) over each side of the truck body and securely fastened.

3.3 WEATHER RESTRICTIONS

Placement of GGHMA will be permitted only when the ambient and surface temperatures are at least fifty degrees (50°) F.

3.4 MATERIAL TRANSFER VEHICLE (MTV)

When the Contractor elects to use an MTV for paving, the MTV shall be capable of performing additional mixing of the GGHMA and depositing the mixture into the paver at a uniform temperature and consistency. The MTV shall have a system to continuously mix the mixture prior to discharge into the paving equipment.

3.5 MIX TEMPERATURE

The minimum temperature of the mixture at the time of placement shall be established during the mix design procedure.

3.6 PAVEMENT THICKNESS

The thickness of the pavement shall be as specified in the Contract Documents.

3.7 TACK COAT

Refer to 32 12 16.13, Part 3, (Plant Mix Asphalt Pavement) except that the resulting coating shall be residual asphalt applied at a rate of three-hundredths to five-hundredths (0.03 to 0.05) gal/yd^2.

3.8 COMPACTION

A. Compaction shall be performed using a minimum of three (3) static steel wheeled rollers, each weighing ten to twelve (10 to 12) tons. The rollers shall follow the paver within five hundred feet (500'). Rolling shall start immediately after placement. In place density shall conform to 32 12 16.13, Part 3, (Plant Mix Asphalt Pavement), except that the density shall be ninety-four to ninety-seven percent (94% to 97%) of maximum density. Sampling and testing shall be performed as specified in 32 12 16.13, Part 3, (Plant Mix Asphalt Pavement).

B. The rollers shall be equipped with a watering or soapy watering system that prevents material from sticking to the rollers.

C. Rollers shall not be used in a vibratory mode. Pneumatic wheeled rollers shall not be used on GGHMA. Roller speed shall be between one and three (1.0 and 3.0) mph. Compaction shall be completed before the mix cools below two-hundred thirty degrees (230°) F.

3.9 CONTROL STRIP

A full lane width control strip having a minimum length of five hundred feet (500') shall be constructed on the finished grade prior to paving start up. The control strip will be used by the Engineer to evaluate the application of the tack coat and to determine the compactive effort. Density requirements are not waived.

3.10 PAVEMENT PROFILE

Refer to the pavement surface profile requirements specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

A. Gap-Graded Hot Mix Asphalt will be measured and paid for at the Contract Unit Price per ton, complete and in place. The payment will be full compensation for furnishing, hauling,preparing tack coat, placing all materials, material transfer vehicle, anti-stripping additive, tack coat, control strips, and for all material, labor, equipment, tools, setting of lines and guides where specified, and incidentals necessary to complete the Work. The paid tonnage will be based on the combined bulk specific gravity of the aggregate (Gsb) mixture used. When the Gsb is within two and seven-tenths to two and eight-tenths (2.70–2.80) the paid tonnage is the tonnage used; when outside this range use the following formula to determine the pay tonnage.

$$PT = T ((AC + (AGG \times 2.75/Gsb) + Y)/100)$$

where:

PT	=	Pay tonnage,
T	=	Actual tonnage weighed,
AC	=	Percent by weight of binder,
AGG	=	Percent by weight of total mixture of mineral aggregates,
Gsb	=	Calculated combined bulk specific gravity of various mineral aggregates used in mixture, and
Y	=	Percent by weight of fiber.

B. Material produced for the demonstration will not be paid for but the cost will be incidental to the item GGHMA.

C. Price Adjustment. Refer to 32 12 16.13, Part 4, (Plant Mix Asphalt Pavement) except as follows:

DENSITY PRICE ADJUSTMENT

PERCENT OF MAXIMUM DENSITY, LOT AVERAGE	PAY FACTOR %
Above 97.0	97
94.0–97.0	100
92.0–93.9	97
90.0–91.9	95
Below 90.0	80 or Rejected at Engineer's Discretion

Note: Any sublot below eighty-nine percent (89.0) will be cause for rejection of the entire lot at the Engineer's discretion.

32 12 16.15 HOT MIX ASPHALT (HMA) FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of utilizing HMA pavement for maintenance of traffic within the existing facilities as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Tack Coat (Rapid Setting): 32 12 16.13, Part 2.1, (Plant Mix Asphalt Pavement).

B. HMA: Hot mix asphalt shall conform to 32 12 16.13, (Plant Mix Asphalt Pavement).

C. Crack Filler: Crack filler shall conform to 32 12 16.13, Part 2.1, (Plant Mix Asphalt Pavement).

D. Production Plant: Production plant shall conform to 03 30 43, (Production Plant).

PART 3 EXECUTION

Refer to the applicable portions of 32 12 16.13, Part 3, (Plant Mix Asphalt Pavement).

PART 4 MEASUREMENT AND PAYMENT

A. Hot mix asphalt for maintenance of traffic will be measured and paid for at the Contract Unit Price per ton. The payment will be full compensation for all tack coat, crack filler, hauling, placing, compacting, maintaining, removal, rehandling, reworking and disposal, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. When hot mix asphalt is part of any base or pavement course used for the Construction and maintenance of temporary detours, approaches, crossings, and widenings, the item of Work will be measured and paid for in conformance with 32 12 16.13, (Plant Mix Asphalt Pavement).

C. Hot mix asphalt for maintenance of traffic when used for temporary and permanent patching at pipe culverts and utilities will not be measured but the cost will be incidental to the pertinent pipe culvert or utility item.

32 13 00 CONCRETE PAVING

32 13 13.13 EXPOSED AGGREGATE SIDEWALKS

PART 1 GENERAL

1.1 DESCRIPTION

A. Exposed aggregate sidewalks shall be used in the pedestrian ramps, as shown on the Contract Plans or as directed by the Engineer.

B. Within the Construction limits of new sidewalks, the Contractor shall adjust all surface fixtures along the line of Work to true line and grade before the sidewalk is placed.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Materials shall conform to 03 30 00, (Portland Cement Concrete Structures).

B. Form Release Compound shall conform to 03 30 00, (Portland Cement Concrete Structures).

C. Concrete Mix No. 2 shall conform to 03 30 00, (Portland Cement Concrete Structures).

D. Welded Wire Fabric shall conform to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

E. Joint Sealer shall conform to 03 30 00, (Portland Cement Concrete Structures).

F. Preformed Joint Fillers shall conform to 03 30 00, (Portland Cement Concrete Structures).

G. Bricks for Masonry and Sewers: Refer to 04 21 13, (Brick Masonry).

H. Mortars: Refer to 04 21 13, (Brick Masonry).

PART 3 EXECUTION

A. The subgrade shall be compacted to ninety-two percent (92%) of AASHTO T-180 Method A after which it shall be accurately trimmed to the proper shape and grade shown by the Plans or directed by the Engineer. Immediately in advance of placing concrete, the subgrade shall be sprinkled with as much water as it can readily absorb. Where Plans do not show section or thickness of the sidewalk, it shall be five inches (5″) thick.

B. Forms shall be substantially constructed of steel and shall be the depth of the concrete. They shall be set to the exact grade required and securely supported and braced so as to avoid any settlement or displacement during concreting. Before concrete is placed against the forms, they shall be thoroughly cleaned and coated with a form release compound each time they are used. Forms shall not be stripped until the concrete has set for at least twelve (12) hours and every precaution shall be taken to avoid damaging the concrete.

C. Handling and batching materials, refer to 03 30 00, (Portland Cement Concrete Structures). Volumetric batching will be permitted. Concrete shall be deposited on the prepared subgrade in successive batches to the full width of the sidewalk. It shall be thoroughly spaded along the edges and shall be tamped to eliminate voids.

D. The concrete shall be mixed in conformance with 03 30 43, (Production Plants). Continuous mixing will be permitted.

E. After the concrete is placed, screeded to a level line and then thoroughly floated, clean wet #4 limestone aggregate shall be broadcast by hand, such that the entire surface is completely covered. A covering of the entire surface will be considered as a single layer of aggregate, spaced such that the distance between each stone is not greater than the aggregate diameter. An edging or grooving tool shall be used along the forms and joints. The edging shall be done to a radius of one-quarter inch (1/4″). Embed the scattered aggregate by carefully patting with darby or flatside of strike-off iron. After initial

embedding and as soon as concrete will support the weight of a workman on kneeboards, hand float the surface so that all aggregate is fully submerged. The grout should completely surround and slightly cover the aggregate so that no holes or openings are left in the surface. If the Contractor uses retarding agents during hot weather, cover slabs with wet burlap or paper. It should be made certain that the material used will not discolor the finished surface. When using retardant and before exposing the aggregate, movement on the slab should be minimized to avoid loosening surface aggregate.

F. Exposing Aggregate: It is important to expose only the tops of the aggregate to minimize the loosening effects of winter freezing. The following method may be used but test panels will be submitted on the method to be employed:

G. Brushing: After the concrete has set up or the period of retardation is completed, a slow stream of water shall be applied to the surface, working from the highest level downward. The water application shall be closely followed by a gentle brooming of the surface with a hair broom. If the Work is allowed to set up a little too long, it will be necessary to employ the bristle broom more vigorously to achieve the desired effect. Depth of exposure should be no more than one-sixteenth inch (1/16″). After completion of the aggregate exposure and a thorough removal of all excesses and debris, the Contractor will apply at least two (2) coats of silicone sealer, of a type approved by the Engineer, to the surface.

H. Expansion Joints: Premolded expansion joints, one-half inch (1/2″) wide shall be provided at street corners, following the projection of the building lines from the building corner to the curb, between the back of curb and sidewalk and between sidewalk and permanent structures; wherever they come in contact. Premolded joints one-quarter inch (1/4″) wide shall be provided through the pavement at intervals not greater than fifteen feet (15’), shall encircle all fixtures of more than twelve inches (12″) in diameter, shall be used to border a block twenty-four inches (24″) square around all water stops and other small fixtures and shall be provided at such other locations as the Engineer may direct. Reference is made to the standard for details covering the Construction of “Expansion Joints”.

I. Cold Weather Protection and Curing: Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavement) for cold weather protection and for concrete curing. During the curing period, all pedestrian and vehicular traffic is prohibited.

J. Backfills:

1. Where the sidewalk is not adjacent to curbs or other structures, suitable approved backfill material shall be used to form an earth shoulder for the concrete for a width of eighteen inches (18″) and/or in compliance with the typical cross-section of improvement.
2. This backfilling shall be done in accordance with the requirements of 31 23 23.10, (Tamped Fill).
3. The frames of utility structures within the Construction limits shall be adjusted to the new grade using brick masonry and mortar. Wood block or pegs will not be permitted. Any vertical adjustment to existing fire hydrants shall be made in accordance with 33 12 19 (Water Utility Distribution Fire Hydrants).

PART 4 MEASUREMENT AND PAYMENT

A. This item shall be paid for at the Contract Unit Price per square foot for exposed aggregate sidewalk. The payment will be full compensation for all excavation, backfill,

disposal of excess or unsuitable material, forms, reinforcement when specified, joints, sealer, compaction, curing, finishing, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. The removal and disposal of unsuitable material will be measured and paid for at the Contract Unit Price for class 2 excavation, which price shall include the cost of using suitable excavation as replacement material. When borrow or selected backfill is authorized as replacement material, payment will be made at the Contract Unit Price Bid for the respective items. All excavation above the top surface of the sidewalk, will be classified in the pertinent class of excavation.

C. When the existing sidewalk is removed and replaced with a new sidewalk, the cost to remove the existing sidewalk will be incidental to the Contract Unit Price for sidewalk.

D. Adjusting of surface fixtures within the Construction limits of a new sidewalk shall not be measured. Adjusting of surface fixtures within the limits of new sidewalk Construction shall be included in the cost of exposed aggregate sidewalk.

32 13 13.14 HOT MIX ASPHALT FOR CONCRETE SIDEWALKS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing hot mix asphalt (HMA) or concrete sidewalks and sidewalk ramps as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Curing materials shall conform to 03 30 00, (Portland Cement Concrete Structures).

B. Form release compound shall conform to 03 30 00, (Portland Cement Concrete Structures).

C. Concrete mix no. 2 shall conform to 03 30 00, (Portland Cement Concrete Structures).

D. Hot Mix Asphalt (HMA) shall conform to 32 12 16.13, (Plant Mixed Asphalt Pavement).

E. Welded wire fabric shall conform to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

F. Joint sealer shall conform to 03 30 00, (Portland Cement Concrete Structures).

G. Preformed joint fillers shall conform to 03 30 00, (Portland Cement Concrete Structures).

H. Bricks for masonry and sewers – Sewers: Refer to 04 21 13, (Brick Masonry).

I. Mortars: Refer to 04 21 13, (Brick Masonry).

PART 3 EXECUTION

3.1 CONCRETE SIDEWALKS

A. Excavation: Refer to 32 16 13.13, (Cast-in-Place Curb and Gutter).

1. Forms:

a. Fixed Form Method. Fixed forms shall be of steel or wood and shall extend to the full depth of the concrete. All forms shall be straight, free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be so that the forms remain in both horizontal and vertical alignment until their removal. The forms shall be thoroughly cleaned and coated with form release compound each time they are used. The concrete shall be set for a minimum of twelve (12) hours before the forms are removed and every precaution shall be taken to avoid damaging the concrete.

b. Slip-Form Method. Slip-form Construction shall conform to the method specified in 34 71 13.20, (Concrete Traffic Barriers) except that joint Construction shall conform to Part 3.

2. Concreting: Before placing concrete the subgrade shall be moistened with as much water as it can absorb. The concrete shall be mixed in conformance with 03 30 43, (Production Plants). Volumetric batching and continuous mixing will be permitted. Concrete shall be deposited on the prepared subgrade in successive batches to the full width of the sidewalk. It shall be thoroughly spaded along the edges and shall be tamped to eliminate voids. It shall be struck off, screeded to the elevation of the top of the forms and finished.

3. Finishing: The surface shall be floated and broom finished. Plastering of the surface is prohibited. All outside edges and all joints shall be edged with a one-quarter inch (1/4″) edging tool.

4. Joints: Joints shall be placed as specified in the Contract Documents. Dummy joints shall be tooled or sawed a minimum of three-quarters inch (3/4″) deep. Joints shall match adjacent joints in curb or pavement. Expansion joint material shall extend the full depth of the concrete.

5. Cold Weather Protection and Curing: Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavement) for cold weather protection and for concrete curing. During the curing period, all pedestrian and vehicular traffic is prohibited.

6. Joint Sealing: Expansion joints shall be cleaned of dirt or other foreign material prior to placement of the joint sealing compound. Joint walls and all surfaces to which the sealing material is to adhere shall be surface dry for at least three (3) hours prior to sealing. No sealing material shall be used until the joints are acceptable to the Engineer. The surface of the sealing compound shall be a maximum of one-eighth inch (1/8″) below the level of the sidewalk surface.

3.2 HOT MIX ASPHALT (HMA) SIDEWALKS

A. Excavation: Excavation, subgrade and forms when required shall conform to paragraphs 3.1 A and B of this Specification.

B. Placement: HMA sidewalks shall conform to 32 12 16.13, (Plant Mixed Asphalt Pavement). When the sidewalk is not formed, backfill material acceptable to the Engineer

shall be used to form an eighteen inches (18″) wide earth shoulder for the HMA or as specified in the Contract Documents.

C. Compaction: Compaction shall be accomplished by means of a roller approved by the Engineer. In areas inaccessible to the roller, a vibrating plate compactor or hand tamping may be used. In any case, the HMA shall be uniformly compacted. Compaction effort shall start as soon as the HMA can be compacted without displacement and shall continue until the material is thoroughly compacted and all marks have been removed.

3.3 BACKFILL

A. Where the sidewalk is not adjacent to curbs or other structures, suitable approved backfill material shall be used to form an earth shoulder for the concrete for a width of eighteen inches (18″) and/or in compliance with the typical cross-section of improvement.

B. This backfilling shall be done in accordance with the requirements of 31 23 23.10, (Tamped Fill). The frames of utility structures within the Construction limits shall be adjusted to the new grade using brick masonry and mortar. Wood block or pegs will not be permitted. Any vertical adjustment to existing fire hydrants shall be made in accordance with 33 12 19, (Water Utility Distribution Fire Hydrants).

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, backfill, disposal of excess or unsuitable material, forms, reinforcement when specified, joints, sealer, compaction, curing, finishing and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. The removal and disposal of unsuitable material will be measured and paid for at the Contract Unit Price for class 2 excavation, which price shall include the cost of using suitable excavation as replacement material. When borrow or selected backfill is authorized as replacement material, payment will be made at the Contract Unit Price Bid for the respective items.

C. When the existing sidewalk is removed and replaced with a new sidewalk, the cost to remove the existing sidewalk will be incidental to the Contract Unit Price for sidewalk.

D. Concrete Sidewalks will be measured and paid for at the Contract Unit Price per square foot of finished surface including sidewalk ramps. Sidewalk ramps with an exposed aggregate finish shall be measured and paid for as specified in 32 13 13.13, (Exposed Aggregate Sidewalks).

E. Hot Mix Asphalt Sidewalks will be measured and paid for at the Contract Unit Price per ton for the mixture placed.

F. Adjusting of surface fixtures within the limit of new sidewalk Construction shall be incidental to the sidewalk Construction.

32 13 13.33 PLAIN AND REINFORCED PORTLAND CEMENT CONCRETE PAVEMENTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing plain and reinforced portland cement concrete pavements as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland Cement Concrete and related products shall conform to 03 30 00, (Portland Cement Concrete Structures).

B. Reinforcement Steel shall conform to the following:

1. Certification: The steel manufacturer shall furnish certification for each heat of steel. This certification shall be a document, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Certifications for metal products, when required, shall include a statement that the material was melted and manufactured in the United States except as provided in the federal guidelines with regard to the furnishing and coating of iron and steel products. A nationwide waiver for this provision has been granted for pig iron and processed, pelletized and reduced iron ore.
2. Deformed Reinforcement: Unless otherwise specified, reinforcement bars and reinforcement bars used as anchoring devices shall be deformed bars conforming to A 615, Grade 60. Deformed bars shall be epoxy coated when specified in the Contract Documents. Epoxy powder shall conform to paragraph 2.1 E.
3. Plain Reinforcement: Unless otherwise specified, dowel bars and dowel bars used as ties in portland cement concrete pavement expansion and Contraction joints shall be plain round steel bars conforming to A 615, Grade 60 or A 36. Bars shall be epoxy coated. Epoxy powder shall conform to paragraph 2.1 E.
4. Stainless Steel Bars: In lieu of epoxy coated plain bars, the Contractor may use stainless steel bars. Deformed bars shall be stainless steel when specified in the Contract Documents. Stainless steel shall conform to A 276, Type SM-29. Deformed stainless steel bars shall conform to A 615 for cross sectional area and deformations.
5. Sleeves for Dowel Bars in Pavement Expansion Joints: Sleeves for dowel bars shall be of sheet metal capable of sliding over two (2) plus or minus one-quarter inch (± 1/4″) of the dowel and shall have a closed end with a stop to hold the end of the sleeve at a minimum distance of one inch (1″) from the end of the dowel bar.
6. Welded steel wire fabric shall conform to M 55. Fabric used in pavement Construction shall be furnished in flat sheets.
7. Welded deformed steel wire fabric shall conform to M 221.
8. Fabricated steel bar mats shall consist of steel conforming to A 184.
9. Wire fabric for pneumatically applied mortar and concrete encasement shall conform to A 185. It shall be fabricated either from size W1.5 wire on three inch

(3″) centers in each direction or from W1 wire on two inch (2″) centers in each direction. It shall be galvanized and galvanized coating for fabric, ties, and connecting wire shall not be less eight-tenths (0.8) oz/ft^2 when tested as specified in A 90.

10. Cold drawn steel wire for concrete reinforcement shall conform to M 32.
    Tie Devices for Concrete Pavement: Tie device sizes shall be as specified in the Contract Documents and produce a frictional force of at least one-hundred sixty (160) lb/ft for each foot of spacing when tested as specified in Maryland Standard Method of Tests (MSMT) 512.
11. Steel strand shall conform to M 203, Grade 270, low relaxation strand.

C. Joint Materials shall conform to the following:

1. Joint sealer and crack filler shall conform to D 3405 as modified by Maryland standard Method of Tests (MSMT) 404. The manufacturer shall furnish certification. This certification shall be a document, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Manufacturer's recommendations regarding heating and pouring temperatures will be used when testing these materials. If a range of temperatures is recommended, the midpoint will be used as the pour point.
2. Silicone Joint Sealer and Crack Filler: Silicone joint sealer and crack filler shall be low modulus, one (1) component compound which, may or may not, require a primer for bonding to concrete. If a primer is required, it shall be as recommended by the sealant manufacturer and shall be placed on the joint faces following the insertion of the backup material. Silicone material, when tested at seventy-three degrees (73°) plus or minus three degrees (± 3°) F and forty-five to fifty-five percent (45% to 55%) relative humidity, shall conform to the following table:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Shore A Hardness, at 7 days	D 2240	10-25
Tensile Strength at 150 % Elongation, psi max	D 412 Die C	45
Elongation, % min	D 412 Die C	700
Adhesion in Peel, lb/inch min	Federal Spec TT-S-00230	20
Flow, 0.01 inch max	T 187	0.3
Tack-Free Time, minutes	D 2377	20-75

Each container of silicone sealer and crack filler shall have a minimum shelf life of six (6) months. Material more than six (6) months old shall be retested.

3. Preformed Joint Fillers: Preformed joint fillers shall conform to M 153. The bituminous fiber type shall conform to M 213; with the bitumen content determined using T 164. The weathering test shall be deleted for either type of material.
4. Preformed Joint Inserts: Preformed inserts shall conform to M 220.
5. Preformed Polychloroprene Elastomeric Compression Joint Seals: The manufacturer shall furnish certification. This certification shall be a document which verifies that the material and Work complies with the applicable.

Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

a. Roadway Seals: Roadway seals for concrete pavement shall conform to M 220.

b. Bridge Seals: Bridge seals shall conform to M 297. The minimum depth of all seals measured at the contact surface shall be at least ninety percent (90%) of the minimum uncompressed width of the seal.

c. Lubricant Adhesive. The lubricant adhesive shall be compatible with the preformed joint seals and concrete. The Engineer will determine if consistency is suitable at the time of installation. The manufacturer shall furnish certification as specified in 03 30 00, (Portland Cement Concrete Structures) showing that lubricant adhesive conforms to the following:

TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, D 1084, Method B, CP min	25000
Film Strength, D 412, psi min	2000
Elongation, D 412, % min	250

d. No lubricant adhesive shall be used after nine (9) months from the date of manufacture. Each container shall be plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture.

6. Neoprene Strip Seals: The manufacturer shall furnish certification as specified in 03 30 00, (Portland Cement Concrete Structures) showing that the neoprene strip seals conform to the following table:

PHYSICAL PROPERTIES FOR PREFORMED ELASTOMERIC STRIP SEALS

PROPERTY	REQUIREMENT	TEST METHOD
Tensile Strength, psi min	2000	D 412
Elongation at Break, %, min	250	D 412
Hardness, Type A Durometer, points	60 ± 5	D 2240 (modified)(a)(c)
Oven Aging, 70 hr at 212° F Tensile Strength, % loss, max Elongation, % loss, max Hardness, Type A Durometer, points change	20 20 0 to + 10	D 573 D 2240 (modified)(a)(c)
Oil Swell, ASTM oil 370 hr at 212° F weight change, % max	45	D 471
Ozone Resistance 20% strain, 300 pphm in air, 70 hr at 104° F	No Cracks	D 1149 (modified)(b)
Low Temperature Stiffening 7 days at 14° F Hardness, Type A Durometer, points change	 0 to + 15	D 2240. D 2240 (modified).(a)(c)
Compression Set, 70 hr at 212° F, % max	40	D 395 Method (modified) (b)(a)

Note: (a) The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more applications than specified in either of the modified test procedures be

used. The specimen modifications shall be agreed upon by the purchaser and producer or supplier prior to testing.

Note: (b) Test in conformance with procedure A of D 518 and ozone concentration is expressed in pphm.

Note: (c) The hardness test shall be performed with the durometer in a durometer stand as recommended in D 2240.

a. Special Molded Intersection Pieces: Where joint elements intersect, a special strip seal element manufactured by molding in one (1) piece from neoprene material similar to that specified above shall be ten inches (10″) from point of intersection to nearest end along center line of joint in any direction. Ends shall be plane and square to facilitate bonding to adjacent extruded areas and corners of sharp angles shall be rounded sufficiently to relieve damaging stress concentrations. Angles to which moldings are fabricated shall be within five degrees (5°) of the actual angle as specified in the Contract Documents to avoid excessive deformation when installed in steel joint components.

b. Lubricant adhesive for use in installing and bonding neoprene seal elements to steel joint components shall be one (1) part moisture curing polyurethane and hydrocarbon solvent mixture having the following physical properties: See table on next page.

TEST AND METHOD	SPECIFICATION LIMITS
Average Weight, lb/gal	8 ± 0.8
Solids Content, % min	65
Adhesives shall remain liquid from, °F	5 to 120
Film Strength, D 412, psi min	2000
Elongation, D 412, % min	250

c. Steel extrusions and neoprene seals shall be matching components by the same manufacturer. The steel extrusions shall have a minimum thickness of three-eighths inch (3/8″). All steel portions of the joint assembly shall be painted with an inorganic zinc rich primer conforming to one of the following:

1) Acrylic: Acrylic intermediate coat shall be a single component one hundred percent (100%) acrylic and have minimum solids of forty-eight percent (48%) by weight and thirty-six percent (36%) by volume. Maximum dry time to touch and re-coat shall be two (2) and eight (8) hours, respectively.

2) Epoxy Polyamide: Epoxy polyamide intermediate coat shall have one (1) component that is the condensation product of the reaction of epichlorohydrin with bisphenol A. The epoxy polyamide shall have a three (3.0) minimum fineness of grind (Hegman Units), and minimum solids of seventy-five percent (75%) by weight and sixty-two percent (62%) by volume. Maximum dry time to touch and recoat shall be six (6) and fifteen (15) hours, respectively.

3) Micaceous Iron: Oxide Moisture Cured Urethane: Micaceous iron oxide moisture cured urethane intermediate coat shall be one (1) component having minimum solids of eighty percent (80%) by weight and sixty percent (60%) by volume. The viscosity shall be

ninety to one hundred (90 to 100) KU. The interval for application of next coat shall be eight (8) hours minimum and thirty (30) days maximum. The coating shall also conform to the moisture cured urethanes additional performance criteria table. The micaceous iron oxide content shall be a minimum of three (3.0) lb/gal.

d. The primer shall be applied in conformance with 03 30 00, (Portland Cement Concrete Structures).

7. Sealer for Loop Detector: Sealing material to seal saw cuts for loop detector wires shall be either Type A, two (2) part epoxy or Type B, one (1) part polyurethane. The manufacturer shall furnish certification as specified in 03 30 00, (Portland Cement Concrete Structures). No aggregate shall be mixed with the sealer material. The sealer shall be applied in conformance with the manufacturer's recommendations.

a. Tests: Tests shall conform to the following tables:

TYPE A – TWO PART EPOXY

TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, cone and plate Viscometer @ 25°C, cps max	12000
Pot life @ 25° C, minutes min	10
Cure time @ 25° C, no tackiness, hr max	1
Hardness, Type A durometer, D 2240	50–60
Tensile elongation, D 638, % min	100
Water absorption, D 570, % per 24 hr max	0.5
Oil absorption, D 471, % max	0.02
Volume resistivity @ 25° C, D 257, ohm-cm min	2.4×10^{10}

TYPE B – ONE PART POLYURETHANE

TEST AND METHOD	SPECIFICATION LIMITS
Viscosity, Brookfield RVF #6 spindle @ 20 rpm 25° C, cps max	30000
Cure time @ 25° C, no tackiness, hr max	24
Hardness, Rex Type A, min	50–60
Tensile strength, D 412, psi min	500
Tensile elongation, D 412, % min	300
ARC resistance, D 495, sec min	70
Dielectric constant, D 150, min	6 @ 50 hz 4.25 @ 500 khz
Nonvolatile content, %	85

8. Roofing Paper: Roofing paper to be used in expansion joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weigh less than thirty-nine and eight-tenths (39.8) lb/one hundred (100) ft^2 and shall not crack when bent ninety degrees (90°) over a one-half inch (1/2") radius at room temperature.

9. Water Stops: Water stops shall be made of rubber or polyvinyl chloride (PVC).

a. The water stop shall be of the shape and dimensions specified in the Contract Documents. The cross section shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the water stop shall be uniform.

b. The water stop shall conform to the following table:

TEST AND METHOD	SPECIFICATION LIMITS
Tensile Strength, D 412, psi min	2000
Elongation @ Break, D 412, % min	300
Hardness, Rubber, Type A durometer, D 2240	55 ± 5
Hardness, PVC, Type A durometer, D 2240	75 ± 5

c. The Contractor shall furnish a test sample for each lot or shipment of water stop. The manufacturer shall furnish certification as specified in 03 30 00, (Portland Cement Concrete Structures).

10. Closed Cell Neoprene Sponge Elastomer: Closed cell neoprene sponge elastomer shall conform to D 1056, Type S. Skin coating is optional. The material shall conform to the following table:

TEST AND METHOD	SPECIFICATION LIMITS
Compression Deflection, D 1056	Pressure necessary for 25 % deflection, 5 – 10 psi, one layer 1/2 inch thick pad @ 70° ± 5° F
Accelerated Aging Test	Change in compression deflection after aging 7 days @ 158° F, 20 % max
Permanent Set*, D 1056	50 % deflection @ 158° F for 22 hr, 40 % max residual permanent set after 10 days recovery, 10 % max
Water Absorption by weight	2 inch immersion of 1.129 inch diameter sample for 24 hr @ room temperature, 10 % max
Water Resistance, D 1171	Quality retention, 6 weeks exposure, 100 %

*Method to calculate permanent set:

$$\text{Permanent set} = \frac{(t0 - t1) \times 100}{t0}$$

where:

t_0 = original thickness of sample, and

t_1 = thickness of specimen thirty (30) minutes after removal of clamps or after ten (10) days recovery.

D. Portland Cement Concrete Plant shall conform to 03 30 00, (Portland Cement Concrete Structures).

E. Epoxy Coating for Reinforcement shall conform to the following:

1. Fusion Bonded Epoxy Powder Coatings for Steel: The epoxy protective coatings shall be a one (1) coat, heat curable, thermosetting powdered coating that is electrostatically applied on metal surfaces as specified in the Contract Documents. Unless otherwise specified in the Contract Documents, the color for structural steel shall match federal standards. For reinforcement steel the color shall be a bright color to contrast with the normal color of reinforcement steel and rust (e.g., orange, red, green, yellow, etc., and not brown or any color in the rust family). If reinforcement steel is coated before fabrication, all hairline cracks and minor damage on fabrication bends shall be patched, even if there is no bond loss. The epoxy coating material shall be selected from the prequalified materials list maintained by the Maryland State Highway Administration Office of Materials and Technology. Epoxy coatings shall conform to D 3963.
2. Touch Up System: Material used for the touch up system shall be a two (2) part epoxy system designated and color matched for patching the epoxy coating used. Patching material shall be available through the manufacturer of the epoxy powder. The patching material shall be fully cured (1) hour after application at thirty-five degrees (35°) F ambient.
3. Certification: The manufacturer shall furnish certification as specified in 03 30 00, (Portland Concrete Cement Structures).

F. Reinforcement, including load transfer assemblies, tie bars, deformed steel bars and longitudinal tie devices shall conform to paragraph 2.1 B and shall be epoxy coated.

PART 3 EXECUTION

3.1 GENERAL

A. At least thirty (30) days prior to the start of paving operations, the Contractor shall submit for approval, a proposed paving plan, including production plants, location of plants with respect to project site, equipment, proposed material sources, and whether the fixed or slip form method shall be used.

B. The Contractor shall protect the pavement against damage from all causes. Any part of the pavement that is damaged shall be repaired or replaced by the Contractor at no additional cost to the City.

C. Concrete shall be mixed, placed, or finished when natural light is sufficient, or an adequate artificial lighting system approved by the Engineer is operated.

3.2 EQUIPMENT

A. All equipment, including the production plant and paving equipment, shall be approved by the Engineer. The plant, including central mixers, batching plant, truck mixers, and hauling equipment shall conform to 03 30 00, (Portland Cement Concrete Structures). The plant shall be ready for inspection by the Engineer at least forty-eight (48) hours prior to the start of Construction operations. Paving equipment shall be on the job site, ready for inspection, at least twenty-four (24) hours prior to the start of Construction operations.

B. Slip form pavers shall be self-propelled on crawler tracks, and no other tractive force other than that which is provided and controlled by the paving machine itself shall be applied. The pavers shall be capable of being automatically controlled for both alignment and grade.

C. The equipment and methods used shall provide a means of obtaining the prescribed weights within the allowable tolerances to achieve the consistency specified with a minimum amount of water to achieve proper placement of the mixture in a condition of maximum density with no segregation, and to finish and cure the pavement as specified herein.

3.3 WEATHER RESTRICTIONS

A. Temperature and Surface Conditions. Concrete placement shall begin only when the ambient air and surface temperature is at least forty degrees (40°) F and rising and discontinued anytime the temperature falls below forty degrees (40°) F. These requirements may be waived for incidental concrete Construction. Placing concrete on a frozen base is prohibited.

B. Precipitation. The Contractor shall have on hand sufficient material, approved by the Engineer, to cover freshly placed concrete as protection against precipitation.

C. Wind. Concrete shall not be placed when the Engineer determines that the wind would have a detrimental effect on the Work.

D. When weather conditions differ from these limits, material en route from the plant to the job site may be used at the Contractor's risk.

E. If placement of the material is stopped by the Engineer for any other reason, all material en route shall be disposed of at no additional cost to the City.

3.4 FOUNDATION

Prior to the installation of fixed forms or the use of slip forms on the foundation, the foundation shall be constructed as specified in the Contract Documents and approved by the Engineer. The total width of the foundation shall be the width of the pavement to be placed, and extend a minimum of four inches (4″) outside the base of the fixed form or the outermost edge of the slip form pavers track or wheel. No additional payment will be made for the extended width.

3.5 FORMS

A. Side forms shall be made of steel not less than seven-thirty seconds inch (7/32″) thick with a depth equal to the edge thickness of the pavement. Built up forms and warped forms are prohibited. Forms shall be of sufficient strength to resist all loads applied in the paving process. Forms shall have a base equal to their height and a flat flanged tread or top surface not less than two inches (2″) wide. Forms shall be a minimum of ten feet (10′) long except for installation along curves with a radius of less than two hundred feet (200'). When the curve radius is less than two hundred feet (200′) the forms shall be a maximum of six feet (6') long or the forms shall be curved. Stake sockets to accommodate a one inch (1″) diameter steel stake shall be provided at the minimum rate of three (3) in each section of the form except forms less than ten feet (10′) long shall have at least two (2) in each section.

B. Forms for keyways shall be rigidly fastened to the road form. Holes shall be provided through both forms and keyways to accommodate tie bars or dowels that may be required.

C. The forms shall be constructed to a tolerance that will ensure proper concrete placement. Tolerances for forms shall be one-eighth inch (1/8″) in ten feet (10′) for the top, and one-quarter inch (1/4″) in ten feet (10′) for the face. The forms shall provide means for locking the ends of abutting sections. Forms shall be clean and coated with an approved form release compound. Forms that are bent, deformed, or broken shall be removed or repaired as directed by the Engineer.

D. Grade controls shall be set at intervals not to exceed twenty-five feet (25′). Forms shall be set a minimum of four hundred feet (400′) prior to concrete placement. When the foundation has been disturbed after the forms have been set to the correct grade, it shall be corrected by the Contractor and approved by the Engineer. The Contractor shall check the alignment and grade for conformance with the Contract Documents. The foundation surface shall be checked using an approved device such as a scratchboard and correction shall be made by the Contractor before concrete placement.

E. Wooden forms may be approved for use in exceptional cases, such as on curves of very short radius or when a nonstandard length of straight form is required.

3.6 SLIP FORM PAVING

A. Minimum width of slip form paving shall be twenty-four feet (24'). If the twenty-four foot (24') width is impractical, written approval is required from the Engineer. The total foundation width shall be graded using machine methods.

B. Grade controls shall be set by string lines at intervals not to exceed twenty-five feet (25′). The foundation shall be constructed as specified in paragraph 3.4 and completed at least one thousand feet (1000) ahead of the paver before paving begins. Paving shall be stopped and a bulkhead Construction joint installed whenever the paving machine comes to within two hundred feet (200′) from the end of the approved foundation. When paving adjacent to an existing pavement, the paver shall have wheels with rubber tires or protective pads on crawler treads. A minimum clearance of one foot (1′) shall be maintained from the outermost edge of the paver track or wheel to the edge of the existing pavement.

C. Slip forms shall be of a length sufficient to prevent slumping or sagging of the sides and top edges of the pavement slab. They shall be spaced and braced to a uniform and constant width and shall also be held vertical. Slip form equipment shall be capable of placing and securing embedded tie bars and keyways in proper position in the plastic concrete before the edge of the pavement slab is free of the slip form.

3.7 REINFORCEMENT

A. Reinforcement shall be as specified in the Contract Documents. Reinforcement shall be kept clean and free from foreign material that may prevent proper bonding of the concrete.

1. Dowel bars at joints shall be installed on the approved foundation parallel to the foundation grade, sufficiently ahead of the placement of slab reinforcement and concrete. Each dowel bar shall be coated with a water insoluble lubricant acceptable to the Engineer. Dowel bars may be machine placed or set on chairs or prefabricated assemblies approved by the Engineer, providing proper alignment, depth and spacing.
2. Tie bars for longitudinal Construction joints may be placed on chairs or machine placed so that upon the initial set of the concrete they shall be at proper alignment, depth and spacing, and shall be at right angles to the center line of the pavement. Chairs or machine placement devices shall be submitted to the Engineer for approval prior to use.
3. Fabric and mat reinforcement shall be furnished in flat sheets and shall be kept flat during placement. Reinforcement clearance shall be as specified in the Contract Documents.
4. When using slip forms, tied reinforcement bars or prefabricated mats may also be installed ahead of the placement of concrete by being supported on chairs set upon the underlying material. Reinforcement installed in this manner shall be in place for a distance ahead of the paver equal to at least five hundred feet (500′) or a two (2) hour run of the paver before any paving may begin. Paving shall be stopped and a bulkhead Construction joint shall be installed whenever it comes to within one hundred feet (100′) of the end of the steel placement. All reinforcement shall be adequately secured against displacement or movement.

3.8 CONCRETE PLACEMENT

A. Before concrete is placed on the foundation, the foundation shall be in a moist condition. In addition, if the concrete is exposed to the direct rays of the sun and the ambient temperature is seventy degrees (70°) F and rising, the forms and reinforcement shall be sprinkled with cool water just before placement of the concrete. Concrete shall be deposited on the foundation within the forms and rehandling shall be minimized.

B. Where concrete is to be placed adjoining a previously constructed lane of pavement, mechanical spreading and finishing equipment may be operated upon the existing lane of pavement only after the existing concrete has reached a compressive strength of three thousand (3000) psi in conformance with 03 30 00, (Portland Cement Concrete Structures). Wheels that rest on the previously completed concrete shall be flat without flanges, and operated far enough from the edge of the slab to preclude spalling or damage. The tread of the wheels shall not be less than three inches (3″) wide. Sampling for control testing shall be done at the time of concrete placement and shall conform to 03 30 00, (Portland Cement Concrete Structures).

C. The total depth of the slab shall be deposited in a single layer except as otherwise specified herein or approved by the Engineer. Two (2) layer placement shall be used for pavement using bar mat or wire fabric reinforcement unless the Contractor demonstrates that the bar mat or wire fabric can be properly supported on devices approved by the Engineer.

D. Single Layer Placement. Reinforcement shall be set on chairs to maintain the stability and proper elevation of the reinforcement. Welding of reinforcement to the chairs in lieu of wire ties will be permitted, except for coated reinforcement, welding will be permitted only if the epoxy coating is applied after the welding. Any damage to epoxy coating shall be repaired as directed by the Engineer using materials specified in paragraph 2.1 E.

E. Two (2) Layer Placements. The placing of concrete and bar mats or wire fabric reinforcement shall be a continuous operation. Concrete shall first be placed to the specified depth of reinforcement; the reinforcement shall then be immediately placed on the freshly deposited concrete. The second layer of concrete shall be placed immediately after the reinforcement is set in place.

3.9 CONSOLIDATION OF CONCRETE

A. Fixed Form Paving. Concrete shall be consolidated by means of immersion type vibrators. The vibrators shall advance with the paving equipment. Vibrator spacing, amplitude and depth shall ensure proper consolidation, clear reinforcement by one-half inch (1/2″) and shall be subject to approval by the Engineer. Special care shall be taken to ensure thorough consolidation along the faces of all forms and joint assemblies. Vibrators shall not come in contact with the side forms, joint assemblies, or underlying material. Excessive vibration which results in segregation shall be avoided.

B. Slip Form Paving. Concrete consolidation systems shall be incorporated in the paving equipment, and shall be submitted to the Engineer for approval.

3.10 FINISHING

A. Machine Finishing. The machine shall be equipped with two (2) transverse screeds with provision for adjustment to ensure that the concrete is placed to the specified crown and grade. Following the transverse screeds, the concrete shall be screeded longitudinally. The width of the Working face of the screeds shall not be less than six inches (6″). A chevron (“V” type) nonreciprocating finishing float or other type as approved by the Engineer shall be used. The float shall be suspended from a frame that does not ride directly on the forms. Following the finishing float, a scraping straightedge ten feet (10′) long, equipped with a long handle shall be used to bring the pavement to the correct grade. When the finishing machine is operated over concrete, which has partially set, provisions shall be made to prevent damage to the concrete by the machine wheels.

B. Hand Finishing. Where approved by the Engineer, hand finishing may be substituted for machine finishing. Rakes are prohibited for handling concrete.

3.11 SLAB SURFACE AND THICKNESS CHECKS

A. Surface Check. After finishing, and before texturing of the concrete, the entire surface of the pavement shall be checked with a ten feet (10′) long metal straightedge approved by the Engineer. The surface shall not deviate from a straight line or vertical curve transversely or longitudinally more than one-eighth inch (1/8″) in ten feet (10′).

B. Thickness Check. After the pavement is placed and before final acceptance, the thickness will be checked by the Engineer from cores cut by the Contractor. Coring shall be as specified in Maryland Standard Method of Tests (MSMT) 552. Cores shall be spaced every one thousand feet (1000) for each lane unless otherwise specified or directed by the Engineer. Core holes shall be filled by the Contractor, at no additional cost to the City. When the thickness of pavement is deficient by more than one inch (1″), the full section of deficient pavement shall be removed and replaced by the Contractor at no additional cost to the City. Deficiencies up to one inch (1″) will be subject to reduced payment as specified in Part 4.

3.12 TEXTURING AND EDGING

A. Texturing. Following concrete finishing and surface check, the roadway surface shall be given a textured finish using a texturing device, which produces transverse corrugations one-eighth inch (1/8″) wide by one-eighth inch (1/8″) deep spaced between five-eighths inch (5/8″) and seven-eighths inch (7/8″). A two inch (2″) space shall be provided between passes of the texturing device and a three inch (3″) space provided between the last corrugation and the centerline of all transverse joints. Texturing shall begin when the concrete surface is plastic enough to allow texturing to the depth specified but dry enough to prevent the plastic concrete from flowing back into the grooves being formed. Care shall be exercised to avoid overlaps and the tearing of the concrete in the texturing operation. Texturing on open sections shall be uniform for the full width of pavement. On closed sections, the last twelve inches (12″) of the roadway adjacent to the curb shall be left untextured to facilitate drainage. The completed textured finish shall be uniform in appearance.

B. Edging. After texturing the surface, and when the concrete has taken its initial set, transverse and longitudinal slabs shall be edged using a tool with a one-quarter inch (1/4″) radius.

3.13 CURING

A. Following texturing and edging, the concrete shall be cured for a minimum of seventy-two (72) hours. Whenever the ambient air temperature falls below forty degrees (40°) F during the curing period, insulated blankets shall be used to maintain the concrete temperature above forty degrees (40°) F. Insulated blankets shall be used in addition to the curing material. The Contractor shall provide a sufficient number of high/low thermometers to monitor the temperature of the concrete. The concrete shall be cured using one of the following methods:

1. Liquid Membrane Forming Compound. A liquid membrane-forming compound used for curing shall conform to 03 30 00, (Portland Cement Concrete Structures) and shall be applied to the surface as soon as the free water has disappeared from the surface. The compound shall be applied using an approved spraying machine having drive wheels that straddle the freshly placed concrete. Standby equipment shall be on site in the event of failure of the spraying machine. The spraying machine shall be equipped with an adequate wind guard and shall produce a fine spray of material that covers the surface with a uniform continuous film. The film shall be free of pinholes and other imperfections and shall be free of checks, cracks or peelings. Discontinuities in the film shall be corrected by application of an additional coat to the affected area within thirty (30) minutes of the original coat. The compound shall be applied in two (2) applications at a rate of one (1) gal/two hundred (200) ft^2 for both coats. Sprayed surfaces subjected to damaging rainfall

within three (3) hours after the second application shall be resprayed at no additional cost to the City.

2. Vertical surfaces of longitudinal and transverse joints shall be kept free of curing compound by the use of rope or other masking methods approved by the Engineer. Sprayed surfaces shall be protected to prevent disruption of the continuity of the membrane. Application of compound by hand operated spraying equipment in irregular areas shall be as directed by the Engineer.
3. Burlap Curing. Burlap conforming to 03 30 00, (Portland Cement Concrete Structures) shall be placed on the freshly placed concrete as soon as practical, without damaging the concrete. Burlap shall be overlapped to provide a double thickness on the entire surface. The burlap shall be saturated with water before placement and kept continuously wet during the curing period.
4. Cotton Mat Curing. Cotton mats conforming to 03 30 00, (Portland Cement Concrete Structures) shall be placed on the freshly placed concrete as soon as practical, without damaging the concrete. Mats shall be saturated with water prior to placement and kept continuously wet during the curing period.
5. Sheet Materials. Sheet materials conforming to 03 30 00, (Portland Cement Concrete Structures) shall be placed on the freshly placed concrete as soon as practical without damaging the concrete. Sheets shall be lapped at least one foot (1′) and extend outside the slab. Laps and edges shall be held securely in place to provide continuous contact of the sheet with the pavement surface.

3.14 FORM REMOVAL OF FIXED FORM PAVING

Unless otherwise directed by the Engineer, forms shall remain until the concrete has set at least twelve (12) hours. The sides of slabs that are not damaged shall be cured for the remaining sixty (60) hours of the seventy-two (72) hour curing period. Damaged or honeycombed areas shall be repaired and cured for an additional seventy-two (72) hours.

3.15 JOINTS

A. Joints shall conform to the details specified in the Contract Documents, be perpendicular to the finished grade of the pavement and be sealed as specified in 03 15 14.01, (Expansion Joints in Structures). Transverse expansion and Contraction joints shall be straight and continuous from edge to edge of the pavement.

1. Transverse Construction Joints. Transverse Construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for thirty (30) minutes or longer. These joints shall be located at a planned joint except in the case of equipment breakdown. When concrete placement cannot be continued, the transverse Construction joint may be installed within the slab unit but not less than ten feet (10′) from a planned transverse joint. Transverse Construction joints shall be doweled as specified in the Contract Documents, and sawed as specified in paragraph 3.1,5, A, 3, a.
2. Expansion Joints. Expansion joints shall be formed by means of a preformed filler material conforming to paragraph 2.1, C, 3. The filler shall be securely held in position by means of metal supports, as approved by the Engineer, which shall remain in the pavement. A removable metal channel cap bar shall be used to hold the parts of the joint in proper position and protect the filler from damage during concreting operations. The cap bar shall be removable without damage to the pavement to provide a space for sealing of the joint. Adjacent sections of filler

shall be fitted tightly together, and shall extend across the full width of the paving lane to prevent entrance of concrete into the expansion space. Expansion joints shall be formed around structures and features that project through, into, or against the pavement, using joint filler of the type, thickness, and width specified in the Contract Documents or as directed by the Engineer.

3. Contraction Joints. Longitudinal and transverse contraction joints shall be constructed by sawing. If gravel aggregate is used, joints shall be tooled or formed by using an insert approved by the Engineer.

   a. Sawed Joints. Sawed joints shall be constructed by sawing a groove in the concrete with a one-eighth inch (1/8″) blade to the depth as specified in the Contract Documents. The time of sawing shall vary depending on existing and anticipated weather conditions and shall prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. Any membrane cured surface damaged during the sawing operations shall be resprayed as soon as the surface becomes dry. After completion of the curing period, the upper portion of the groove shall be widened by sawing to the width and depth specified. The saw blades may be single or gang type, with one or more blades mounted in tandem. Saw cutting into load transfer devices is prohibited. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint.

   b. Insert Type Contraction Joints. Insert type contraction joints shall be constructed by installing a preformed insert in the plastic concrete to form a weakened plane to induce cracking. The equipment for installing inserts shall be a machine equipped with a vibratory bar for cutting a groove in the plastic concrete for placement of the insert or for vibrating the insert into place at the prescribed joint location. Installation of the insert shall be to the required depth throughout the full width of the paving lane. Vibration units shall be arranged so that the vibration will be uniformly distributed throughout the bar. The intensity of vibration shall be adjustable as necessary to form a groove of proper size for the filler or for forcing the insert into the plastic concrete and consolidating the concrete around the in-place insert. For concrete placed by slip form pavers, the edges of the plastic concrete shall be supported to prevent slumping during the vibration and placement of inserts. The vibratory float shall be used following placement of the insert material in lieu of hand floating or troweling the finish. The insert shall be installed in the plastic concrete immediately following the final machine finishing with a maximum of two (2) joint spacings between the finishing machine and the inserter. Additional straightedge and texturing operations shall be accomplished without disturbing the installed insert. Adjacent sections of the joint inserts within each slab unit shall be securely joined together, and the insert shall be thoroughly consolidated against the full depth of the insert. The insert shall be perpendicular to the finished grade of the pavement and shall be straight in alignment at the joint locations specified, with the top of the insert flush or not more than one-eighth inch (1/8″) below the pavement surface. After the completion of the curing period, the top portion of fiberboard fillers or sawable preformed inserts shall be removed by sawing with a power saw as approved by the Engineer.

3.16 PAVEMENT PROFILE

Refer to pavement surface profile requirements specified in the Contract Documents.

3.17 OPENING TO TRAFFIC

The pavement may be opened to vehicular traffic after having attained a compressive strength of three thousand (3000) psi. Tests of field samples shall conform to T 23.

PART 4 MEASUREMENT AND PAYMENT

A. Plain and reinforced portland cement concrete pavements will be measured and paid for at the Contract Unit Price per square yard for the pertinent portland cement concrete pavement item. The square yard measurement will be computed on the basis of plan width and as-built length measured along the pavement centerline. The payment will be full compensation for all concrete, forms, reinforcement steel, chairs, epoxy coating, finishing, curing, joints, joint construction, saw cutting, and joint sealing and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Pavement Thickness Price Adjustment. Payment for areas that are accepted at a reduced price for deficient thickness will be adjusted by the factors shown in the following table. Deficiencies will be determined by procedures specified in paragraph 3.11. There will be no additional payment for excess thickness.

PAVEMENT THICKNESS PRICE ADJUSTMENT

DEFICIENCY IN INCHES	PERCENT OF PAYMENT CONTRACT UNIT PRICE
0.00 to 0.20	100
0.21 to 0.30	80
0.31 to 0.40	72
0.41 to 0.50	68
0.51 to 0.75	57
0.76 to 1.00	50
Greater than 1.00 *See paragraph 3.11B	0*

32 13 13.43 CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing continuously reinforced portland cement concrete pavement on a prepared subgrade as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Pavements) and the following:

B. Reinforcement. Reinforcement, including load transfer assemblies, tie bars, deformed steel bars and longitudinal tie devices shall conform to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement) and shall be epoxy coated. The Contractor shall select the type of reinforcement from one of the following:

1. Deformed steel bar mats conforming to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement). The longitudinal bars shall be No. 5, Grade 60, and the transverse bars shall be No. 4, Grade 60.
2. Loose deformed steel bars conforming to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement). The longitudinal bars shall be No. 5, Grade 60 with a minimum length of forty feet (40′), and the transverse bars shall be No. 4, Grade 60. The longitudinal bars shall have a minimum length of forty feet (40′).
3. Welded deformed steel wire fabric conforming to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

PART 3 EXECUTION

3.1 GENERAL

Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement) except as modified herein.

3.2 PLACING REINFORCEMENT

A. The reinforcement shall be preset on chairs or chair bars with the transverse members placed down. Placement of the longitudinal bars shall be within the tolerances specified in the Contract Documents when measured from the top of the pavement to the bottom of the bar.

B. Rust, mud, oil or other detrimental coatings shall be removed before placing the concrete. The mat or fabric reinforcement shall be flat and free from distortions. Loose steel bars shall be free from kinks or bends that may prevent them from being properly assembled or installed.

C. Chairs or chair bars shall be designed to support the reinforcement in position without deflection or displacement during the placing and consolidation of the concrete. Chair bases shall have sufficient bearing to prevent overturning or penetration into the subgrade. The design of the chairs shall not impede the placing of the concrete. The Contractor shall obtain the Engineer's approval for the type of chair or chair bar to be used. Welding of chairs to the transverse bars prior to epoxy coating will be permitted.

D. If the support system does not hold the reinforcement within the specified tolerances, the Contractor shall increase the number of chairs or take other steps to ensure proper positioning of the steel.

3.3 PLACING CONCRETE

A. Concrete shall be placed in one (1) lift, and be internally vibrated over its full width and depth by immersion vibrators mounted at intervals not to exceed thirty inches (30″) center to center, across the full width of the slab being placed. The vibrators shall be operated at a frequency and an amplitude sufficient to be perceptible on the surface of the concrete more than one foot (1′) in any direction and shall be equipped to provide variable controlled frequencies. The battery of vibrators shall advance longitudinally with the paving machinery. The vibrators shall be hinge mounted to facilitate riding over any obstruction and shall be set to clear the reinforcement by approximately one-half inch (1/2″).

B. All screeding and vibrating operations shall stop immediately whenever forward motion of the paving machinery is stopped.

3.4 JOINTS

A. Transverse expansion or contraction joints are prohibited in continuously reinforced portland cement concrete pavement. Transverse Construction of bulkhead joints shall be formed only at the end of any working period or when necessary to stop concreting operations for more than thirty (30) minutes. They shall be formed with an approved header board in conformance with the cross section of the pavement, placed at right angles to the centerline, and perpendicular to the surface. Additional bars shall be furnished and installed as specified in the Contract Documents. The pavement shall be finished to the header board without edging. These joints shall be made with extreme care and the bulkhead kept clean. The roadway reinforcement shall extend continuously through the joint. The reinforcement extending through the joint shall be securely supported on chairs or wooden sills to prevent it from deflecting.

B. Paving operations shall resume when the Engineer determines that the concrete has sufficiently set. The bulkheads and all debris shall be removed, and the joint shall be cleaned before placing concrete against it.

C. All joints shall be sealed as specified in 32 13 73.12, (Joint Sealing of Portland Cement Concrete Pavements).

3.5 TERMINAL JOINTS

Terminal joints shall be constructed as specified in the Contract Documents.

3.6 THICKNESS CHECK

Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

3.7 PAVEMENT PROFILE

Refer to the Pavement Surface Profile requirements in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

A. Continuously Reinforced Portland Cement Concrete Pavement will be measured and paid for at the Contract Unit Price per square yard. The square yard measurement will conform to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement). The payment will be

full compensation for all concrete, forms, reinforcement steel, chairs, epoxy coating, finishing, curing, joints, joint construction, saw cutting, and joint sealing, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Pavement Thickness Price Adjustment. Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

C. Terminal Joints. Terminal Joints will be measured and paid for at the Contract Unit Price per linear foot. The payment will be full compensation for all steel beams, stiffener plates, end plates, drilled holes, welding, cutting, styrofoam, joint filler, concrete, reinforcement, bond breaker, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

32 13 73.12 JOINT SEALING OF PORTLAND CEMENT CONCRETE PAVEMENTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of cleaning and sealing portland cement concrete pavement joints as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Joint Sealers: Joint sealers shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Concrete Pavement).

B. Preformed Joint Fillers: Preformed joint fillers shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Concrete Pavement).

C. Backer Rod: Backer rod used with joint sealer shall be flexible, compressible, nonshrinkable, have a surface that will prohibit bond with the joint sealer and be capable of uniformly containing the joint sealer within the desired shape factor. Hard rubber and materials that deform at sealer application temperatures or swell when wet are prohibited.

PART 3 EXECUTION

3.1 GENERAL

Joints shall be sealed the same day they are shaped and prepared, and shall be completed prior to opening the roadway to traffic, unless otherwise directed by the Engineer. Joints not sealed the same working day shall be re-cleaned and dried as specified in paragraph 3.3.

3.2 JOINT CONSTRUCTION

Joint construction shall be as specified in 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavement). When the joint is tooled, preformed joint fillers are prohibited.

3.3 JOINT PREPARATION

A. Joints shall be cleaned by one of the following methods as approved by the Engineer:

1. High pressure water blasting.
2. Abrasive blasting.
3. Oil free air blowing at a minimum of ninety (90) psi.

B. All joint walls and surfaces to which the joint material is to adhere shall be dry prior to installing the joint filler.

C. All prepared joints will be inspected and approved by the Engineer prior to sealing.

3.4 SEALING

A. Preformed joint filler shall be installed in conformance with the manufacturer's recommendations and the Contract Documents. The Contractor shall insert the backer rod as specified in the Contract Documents.

B. Silicone sealer shall be installed in conformance with the manufacturer's recommendations.

C. Backer rods are not required in longitudinal joints.

D. The ambient air and pavement temperatures shall both be a minimum of forty-five degrees (45°) F and rising at the time of sealer application.

E. Sealer that is hot applied shall be heated as specified in the manufacturer's recommendations in a kettle or other equipment acceptable to the Engineer. The kettle shall have a mechanically operated agitator, recirculation pumps, and a positive thermostatic temperature control. The applicator wand and all connecting hoses shall be insulated. Overheating or direct heating of the sealer is prohibited.

F. Sealer that has been overheated, subjected to heating for more than four (4) hours, or any amount that remains in the applicator wand at the end of the day's operation shall be withdrawn and disposed of. Prior to the start of each day's operation, the Contractor shall withdraw and dispose of a minimum of one (1) gal of sealer drawn from the container through the applicator wand.

G. All joints shall be filled with sufficient material that will result in the final surface of the sealer being recessed one-quarter inch (1/4") below the surface of the pavement. Any joint with the sealer recessed more than five-sixteenths inch (5/16") below the surface of the pavement two (2) hours after sealing shall be resealed.

H. Silicone sealer shall be tooled so that the final surface of the sealer will have a parabolic shape in the surface cross sectional area. The deepest point at the center of the joint shall be five-sixteenths inch (5/16") below the pavement surface. The Contractor shall use a

tool approved by the Engineer that is capable of obtaining the parabolic shape at the surface of the sealer.

I. Curing time for silicone material varies with temperature and humidity and therefore may delay opening the pavement to traffic. The Contractor is advised to consult the manufacturer's recommendations for curing time.

J. The Contractor shall remove any excess sealer from the surface of the pavement.

K. All traffic shall be kept off the pavement surface until the sealer has cured.

L. Any sealer that pulls loose from the joints or shows excessive bubbling within one (1) week after opening the pavement to traffic shall be replaced by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. Joint Sealing of Portland Cement Concrete Pavement will be measured and paid for at the Contract Unit Price per linear foot of joint unless otherwise specified in the Contract Documents. The payment will be full compensation for cleaning existing joints, furnishing, hauling, placing all materials including preformed joint filler, joint sealer, backer rod, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Joint Construction and sealing will not be measured but the cost will be incidental to the Contract Unit Price for the pertinent portland cement concrete pavement item.

32 15 00 AGGREGATE SURFACING

32 15 41 CHIP SEAL SURFACE TREATMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of applying one or two (1 or 2) seal coats or a prime coat followed by one or two (1 or 2) seal coats as specified in the Contract Documents or as directed by the Engineer. The seal coat shall consist of applying emulsified asphalt followed by an application of aggregate. The prime coat, when required, shall consist of preparing and treating an existing surface with emulsified asphalt.

PART 2 PRODUCTS

2.1 MATERIALS

TABLE A

MATERIAL	DIVISION	APPLICATION	SIZE OR GRADE	SPREAD RATE lb/yd^2	SPRAY TEMP °F	SPRAY RATE SINGLE COAT OR FIRST COAT gal/yd^2	SPRAY RATE FOR SECOND COAT (Double) gal/yd^2
Aggregate	32 11 23.10	Single or First Coat	No. 7	25-50	—	—	—
		Second (Double Coat)	No. 8	20-35	—	—	—
Emulsified Asphalts	32 12 16.13 Part 2.1 A 3	Seal Coat	CRS-1	—	70–140	0.3–0.5	0.2–0.4
			CRS-2	—	140–160	0.3–0.5	0.2–0.4
			RS-1	—	70–140	0.3–0.5	0.2–0.4
			RS-2	—	140–160	0.3–0.5	0.2–0.4

PART 3 EXECUTION

3.1 CONSTRUCTION

A. At least thirty (30) days prior to the start of placement of the chip seal surface treatment; the Contractor shall submit a proposed plan, including equipment and material sources to the Engineer for approval.

B. The Contractor shall protect the treated pavement against damage from all causes. Any part of the pavement that is damaged shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no additional cost to the City.

3.2 EQUIPMENT

A. All equipment shall be subject to approval by the Engineer.

B. Asphalt Distributing Equipment. Asphalt distributing equipment will be inspected and calibrated prior to use and shall bear a current inspection and calibration tag. A calibration chart showing the total capacity, in gallons, of the distributor tank, and the fractional capacity for each one-quarter inch (1/4″) of tank depth shall be carried in the unit. The unit shall be capable of uniformly applying the specified material on variable widths of surface at the rates specified in Part 2.1. In addition, the equipment shall include the following:

1. A fifth wheel tachometer for maintaining uniform speed.
2. A thermometer graduated in two degrees (2°) F increments to determine the specified temperature ranges.
3. Heaters for uniformly heating the materials to the proper temperatures.
4. Full circulation spray bars that are laterally and vertically adjustable, plus a hand spray.
5. A calibrated tank to determine the quantity of asphalt in each load and the amount used.

6. A valve or petcock built into the equipment for sampling the asphalt.
7. A motor driven pump with pressure gauges to deliver the material to the spray bars. When a variable speed pump and metering system is used, the Contractor shall provide the Engineer with charts prepared by the manufacturer for selecting the proper pump speed for each application.

C. Aggregate Spreader. The aggregate spreader shall be either self-propelled or attached to a truck tailgate.

D. Rollers. Refer to 32 12 16.13, Part 3.2, C (Plant Mix Asphalt Pavement).

3.3 WEATHER RESTRICTIONS

The chip seal surface treatment shall be placed only when the ambient air and surface temperature is at least fifty degrees (50°) F and rising. Pavement shall be clean and dry. When weather conditions differ from these limits, material en route from the plant to the job site may be used at the Contractor's risk. If placement of the material is stopped by the Engineer, all material en route shall be disposed of at no additional cost to the City.

3.4 FOUNDATION PREPARATION

Prior to placement of the chip seal surface treatment material, the foundation for the chip seal shall be constructed as specified in the Contract Documents and as directed by the Engineer. When paving over existing pavement, ruts and potholes shall be repaired to provide a smooth surface for the application of the chip seal surface treatment.

3.5 PRIME COAT

Prior to the application of the prime coat, the surface shall be cleaned of all loose and foreign materials. The prime coat shall be uniformly applied to the surface at the application rate specified in Part 2.1. Excess material in pools shall be removed before the next coat.

3.6 FIRST SEAL COAT

A. A minimum of twenty-four (24) hours after the application of the prime coat, emulsified asphalt shall be sprayed on the surface at the application rate specified in Part 2.1.

B. Immediately following the asphalt application, a dry, dust free aggregate shall be spread on the surface at the application rate specified in Part 2.1. Excess aggregate shall be removed and all areas containing insufficient aggregate shall be corrected.

3.7 ROLLING

Immediately following the aggregate application, the surface shall be rolled until the aggregate is uniformly embedded into the asphalt. The rolling shall be discontinued if the aggregate begins to crush.

3.8 SECOND SEAL COAT

When specified, after the first seal coat has cured a minimum of twenty-four (24) hours, a second seal coat shall be applied to the surface, omitting the prime coat. The application rate for emulsified asphalt and aggregate shall be as specified in Part 2.1. Excess

aggregate shall be removed and all areas containing insufficient aggregate shall be corrected. The surface shall then be rolled as specified in Part 3.7.

3.9 TRAFFIC

Completed sections shall be closed to traffic until the final seal coat has completely cured as directed by the Engineer. The Contractor shall maintain the treated surface after it has been opened to traffic until final acceptance.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for the foundation preparation, furnishing, hauling, preparing, removing excess aggregate, placing materials, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Chip Seal Surface Treatment will be measured and paid for at the Contract Unit Price for one or more of the items below as specified in the Contract Documents.

C. No. 7 Aggregate for Single Coat Chip Seal Surface Treatment per ton.

D. No. 8 Aggregate for Second Coat Chip Seal Surface Treatment per ton.

E. Emulsified Asphalt for Seal Coat per gallon.

F. The actual number of gallons of emulsified asphalt distributed will be corrected to the corresponding volume at sixty degrees (60°) F as determined by use of conversion tables furnished by the City.

32 16 00 CURBS AND GUTTERS

32 16 13.13 CAST IN PLACE CONCRETE CURBS AND GUTTERS (CURB, COMBINATION CURB AND GUTTER AND MONOLITHIC MEDIAN)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing concrete curb, concrete combination curb and gutter, concrete curb openings, concrete monolithic median, and hot mix asphalt (HMA) curb as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Crusher Run Aggregate CR 6 shall conform to 32 11 23.10, (Aggregate Base Course).

B. Aggregate, Size No. 57 shall conform to 32 11 23.10, (Aggregate Base Course).

C. Curing Materials shall conform to 03 30 00, (Portland Cement Concrete Structures).

D. Form Release Compound shall conform to 03 30 00, (Portland Cement Concrete Structures).

E. Concrete Mix No. 2 shall conform to 03 30 00, (Portland Cement Concrete Structures).

F. Hot Mix Asphalt shall conform to 32 12 16.13, (Hot Mix Asphalt Pavement).

G. Tack Coat shall conform to 32 12 16.13, (Hot Mix Asphalt Pavement).

H. Reinforcement Steel shall conform to 32 13 13.33, (Plain and Reinforced Portland Cement Pavement).

I. Joint Sealer shall conform to 03 30 00, (Portland Cement Concrete Structures).

J. Preformed Joint Filler shall conform to 03 30 00, (Portland Cement Concrete Structures).

K. Borrow Excavation shall conform to 31 23 16.12, (Select Borrow Excavation).

PART 3 EXECUTION

3.1 CONCRETE CURB, COMBINATION CURB AND GUTTER AND MONOLITHIC MEDIAN

A. Excavation: Excavation shall be to the specified depth and to a width that permits installation and bracing of the forms. The subgrade shall be compacted to ninety-two percent (92%) density in conformance with T 180, Method A and trimmed to the proper shape and required grade. All soft and unsuitable material shall be removed and replaced with suitable material approved by the Engineer.

B. Forms

1. Fixed Form Method. Fixed forms shall be steel of an approved design, securely fastened and braced to prevent any movement during the placing of concrete. Forms shall extend to the full depth of the concrete and be a minimum of ten feet (10′) long. When installation is made along curves where the radius of the curb face is less than two hundred feet (200'), flexible or curved steel or wooden forms a maximum of six feet (6') long shall be used. Both wooden and steel forms shall be properly designed, acceptable to the Engineer and installed to prevent buckling or warping. The tolerance shall not exceed one-quarter inch (1/4″) in ten feet (10′) in either the grade or alignment. Forms shall be thoroughly cleaned and coated with a form release compound each time they are used.
2. Slip-Form Method. Refer to 03 30 00, (Portland Cement Concrete Structures).

C. Concreting: Concrete shall be mixed in conformance with 03 30 43, (Production Plants). Volumetric batching and continuous mixing will be permitted. When the subgrade is dry, it shall be moistened with as much water as it can absorb. Consolidation of concrete placed in the forms shall be by spading or other methods approved by the Engineer. Except for curb face forms, the forms shall remain in place for a minimum of twelve (12) hours and precautions taken to avoid damaging the concrete. Curb face forms shall be stripped as soon as the concrete will retain its shape.

D. Depressed Curbs: Curbs shall be depressed at entrances and sidewalk ramps as specified in the Contract Documents or as directed by the Engineer.

E. Openings: Drainage openings for the purpose of outletting rain spout water or other drainage shall be provided by constructing insert openings within the curb as directed by the Engineer. Curb openings shall be provided as specified in the Contract Documents.

F. Finishing: Concrete shall be struck off to the cross section specified after which it shall be finished, floated smooth and followed with a broom type textured finish. The Engineer may permit other methods of finishing for the purpose of matching adjacent concrete finishes. Plastering is prohibited. All exposed edges shall be edged with a one-quarter inch (1/4″) edging tool except the face edge of curb shall have a one inch (1″) radius. When finished, the top surface of curbs and medians as well as the faces shall show no deviation from grade and alignment in excess of one-quarter inch (1/4″) per ten feet (10′). All honeycombed and damaged areas shall be repaired immediately after the removal of the forms in a manner acceptable to the Engineer.

G. Joints

1. Fixed Form Method: Spacing between joints shall be ten feet (10') except where shorter spacing is necessary for closures and conformity to expansion and contraction joints in contiguous concrete pavements. No joint spacing shall be shorter than four feet (4'). The joints shall be formed by using plate steel templates one-eighth inch to three-sixteenths inch (1/8″ to 3/16″) thick and shall have a width and depth equal to the unit cross section. The templates shall be set perpendicular to the grade and line of the unit. Intermediate templates or sections of templates are prohibited. Where stationary Structures such as bridges and inlets are encountered, an expansion joint shall be constructed for the full depth using one-half inch (1/2″) preformed expansion joint filler. Expansion joints shall be constructed at points of curves, tangents, at locations coinciding with adjoining pavement joints and as specified in the Contract Documents or as directed by the Engineer. Only the joints in the gutter portion of the combination curb and gutter and one inch (1″) up the face of all joints and expansion joints of monolithic medians shall be sealed. Expansion joints are not required when adjacent to a flexible pavement or away from any pavement.
2. Slip-Form Method: Joint construction shall be as specified in 32 13 13.13, (Sidewalks), except that joint spacing shall be as specified.

H. Cold Weather Construction and Curing: Refer to 32 13 13.33, (Plain and Reinforced Portland Cement Concrete Pavement) for cold weather Construction and for concrete curing.

I. Backfill: After the forms have been stripped and any necessary repairs are satisfactorily completed, the spaces in front and back of the curb, combination curb and gutter, and median shall be backfilled to the required elevations using material approved by the Engineer prior to any adjacent roadway rolling.

3.2 HOT MIX ASPHALT (HMA) CURB

A. HMA curb shall be placed by a self-propelled machine. The machine shall form curbing that is uniform in texture, shape, density and to a template as specified in the Contract Documents unless otherwise approved by the Engineer.

1. The base upon which the curb is to be placed shall be clean, dry and stable. It shall be tack coated with asphalt of the type and amount as directed by the Engineer.

2. When required, the curb shall be backfilled after it has sufficiently hardened to prevent damage. The backfill shall be consolidated by tamping or rolling.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all concrete, hot mix asphalt, forms, excavation, backfill, disposal of excess material, drainage openings, joint sealer, tack coat, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. The removal and disposal of unsuitable material will be measured and paid for at the Contract Unit Price for class 2 Excavation, which price shall include the cost of using suitable excavation as replacement material. When borrowed or selected backfill is authorized as replacement material, payment will be made at the Contract Unit Price Bid for the respective items.

C. When existing curb or combination curb and gutter is removed and replaced with new curb or combination curb and gutter, the cost of the removal will be incidental to the Contract Unit Price for the new item.

D. Curb, Combination Curb, Gutter and Monolithic Median will be measured and paid for at the Contract Unit Price per linear foot. Hot Mix Asphalt Curbs, Concrete Curbs, and Concrete Combination Curb and Gutter will be measured along the front face of the curb. Concrete monolithic median will be measured along the centerline of the finished top of median.

E. Concrete Curb or Concrete Combination Curb and Gutter Openings will be measured and paid for at the Contract Unit Price per each.

32 16 40 STONE CURBS

32 16 40.13 GRANITE CURBS

PART 1 GENERAL

The Contractor will be required to furnish and install granite curbing as indicated on the plan or as directed by the Engineer. All Work shall be in reasonably close conformity with the lines and grades shown on the Plans or as established by the Engineer.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

A. Granite shall conform to structural grade of ASTM C 615. The curbstone shall be of hard and durable granite of a uniformly grayish white color and satisfactory to the Engineer, free from seams which would impair its structural integrity and of a good smooth splitting appearance. The straight curbing shall be in lengths of not less than two feet (2′) or more than six feet (6′). When the curbing is used on a curve of one hundred feet (100′) radius or less, the length shall be as directed by the Engineer, except that when the edging is to be on a radius of ten feet (10′) or less, the maximum length shall be one foot (1′). The

curbing shall have a minimum thickness of three inches (3″) and a maximum thickness of six inches (6″).

B. The exposed face of all curbing shall be smooth quarry split to an approximate true plan and shall have no projections or depressions which will cause over one inch (1″) to show between a two foot (2′) straightedge and the face when the straightedge is placed as closely as possible on any part of the face. If projections on the face are more than that specified, they shall be addressed so as to conform as directed above. The top and bottom lines of the face shall be pitched off in a straight line and shall not show over one inch (1″) between stone and straightedge. When a straightedge is placed along the entire length of top and bottom lines and viewed from a direction at right angles to the plane of the face, the top line shall not show over one inch (1″) when viewed from a direction in the plane of the face. The ends shall be square to the plane of the face and so finished that when the stones are placed end to end as closely as possible, no space of more than one and one-half inches (1-1/2″) shall show in the joint for the full width of the face except that where the edging is to be used on a curve having a radius of ten feet (10′) or less. The ends of the stone shall be cut so as to provide a finished joint for the full width of the face and not more than three quarters inch (3/4″). The lines at the ends shall be pitched with no variation from the plane of the face by not more than one-quarter inch (1/4″). Drill holes shall not be more than three and one-half inches (3-1/2″) in depth or one-half inch (1/2″) in diameter. The sides shall not be under the square more than four inches (4″) or over the square at the back more than one inch (1″).

PART 4 MEASUREMENT AND PAYMENT

The installation of granite curb shall be paid at the Contract Unit Price Bid per linear foot of “granite curb”. This price shall be full compensation for the cost of furnishing all materials, equipment, fill, concrete, excavation, saw cutting, expansion joint material, and labor necessary to complete the Work. Payment will be made for the actual number of linear feet installed as called for in the Plans or as directed by the Engineer.

32 17 00 PAVING SPECIALTIES

32 17 13.10 WHEEL STOPS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, placing and anchoring preformed wheel stops as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Mix No. 2 shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

B. Reinforcement Steel shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Pavement).

C. Recycled Composite Material Wheel Stops shall be as specified by the manufacturer

D. Recycled Composite Material. Wheel stops manufactured of recycled composite material shall be as specified by the manufacturer and shall be insect resistant. The manufacturer shall furnish a certification. A certification is a document, which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/ vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

PART 3 EXECUTION

Wheel stops shall be located and secured in place as specified in the Contract Documents. Only one (1) type of wheel stop will be permitted for each project.

PART 4 MEASUREMENT AND PAYMENT

Wheel Stops will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for all anchors, material, labor, equipment, tools, and incidentals necessary to complete the Work.

32 17 23 PERMANENT PAVEMENT MARKINGS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and applying permanent pavement markings to various surfaces at locations and patterns as specified in the Contract Documents or as directed by the Engineer. This includes line markings, letters, numbers, arrows, and symbols.

PART 2 PRODUCTS

2.1 MATERIALS

A. Permanent Pavement Markings. Refer to Contract Documents.

B. All pavement marking materials shall be evaluated on the National Transportation Product Evaluation Program (NTPEP) North Regional Facility test deck. The Contractor shall provide the Engineer with a printed copy of the manufacturer's recommendations for use and installation of pavement markings. All pertinent material safety data sheets (MSDS) shall also be included with the manufacturer's information sheets.

PART 3 EXECUTION

3.1 QUALITY ASSURANCE/QUALITY CONTROL

A. The Contractor shall submit in writing, a proposed quality control plan, conforming to the quality control plan requirements. This plan shall be submitted to the Engineer for approval before the pre-striping meeting and at least two (2) weeks prior to the start of Work. The plan shall contain procedures for random sampling as specified in Maryland

Standard Method of Tests (MSMT) 729, and shall show how the Contractor proposes to control the equipment and material to ensure conformance with the Specifications. The plan shall contain personnel certifications, inspection, and record keeping procedures, and minimum frequencies of sampling and testing as specified in Maryland Standard Method of Tests (MSMT) 729. The plan shall also detail when and how corrective action will be taken for unsatisfactory Construction practices and deviations from the Specifications. Any deviation from the quality control plan shall be cause for immediate suspension of the marking operation and a meeting between the Contractor and the City will be required prior to restarting of pavement marking.

1. Placement: Permanent pavement marking placement operations shall not begin until the Engineer has approved the Contractor's quality control plan.
2. Certified Technicians: Quality control technicians shall have a current City certification document to be presented to the Engineer.
3. Records: The Contractor shall maintain complete records of quality control inspection results, including any action taken to correct problems, and shall submit copies to the Engineer daily. The Contractor shall identify where the quality control tests were performed.
4. Quality Assurance: The City will provide quality assurance by:

    a. Conducting independent sampling and testing separate from the Contractor.
    b. Periodically observing testing performed by the Contractor.
    c. Directing the Contractor to take additional samples and perform additional tests at any time and at any location.
    d. Monitoring the Contractor's conformance with the quality control plan.

B. Certified Technicians. The Contractor shall provide City certified technicians to perform quality control testing and sampling. The technicians shall demonstrate to the Engineer that they have a thorough knowledge of sampling and testing procedures as specified in Maryland Standard Method of Tests (MSMT) 729. Quality control shall be performed during the marking operations in conformance with the approved quality control plan. The Contractor shall identify where quality control tests were performed. Quality control test results shall be submitted to the Engineer at the end of each workday for that day's Work. Should a certified technician become delinquent in any of their duties (i.e., failed to have all the proper test equipment on the site, failed to perform tests, failed to submit documents to the Engineer at the end of the day, reported information that varies substantially from the City's results), then the technician's certification shall become invalid and a recertification shall be required. All pavement marking operations shall be suspended until the Contractor provides a certified replacement technician.

C. Evaluation of quality control results and testing performed by the City will provide the basis for Final Acceptance.

D. Independent assurance audits will be performed by the City to confirm and assure that both the quality control personnel's test methods and quality control test equipment are in reasonable conformity with City Specifications.

3.2 CLEANING PAVEMENT SURFACES

A. Pavement surfaces shall be dry and free of oil, dirt, grease, and other contaminants prior to application of pavement markings. Surfaces not in conformance shall be cleaned by the

Contractor to a width of four inches to six inches (4″ to 6″) wider than the marking to be applied.

B. Existing pavement markings that conflict with new or altered traffic patterns shall be completely removed by the Contractor. The method used by the Contractor for removal shall not damage the pavement surface and shall be approved by the Engineer. Any pavement damaged shall be repaired or replaced as determined by the Engineer at no additional cost to the City.

3.3 APPLICATION

A. Before any pavement marking Work is begun, a schedule of operations shall be submitted to and approved by the Engineer. All pavement markings shall be applied in conformance with the manufacturer's recommendations.

B. When permanent pavement markings are applied under traffic, the Contractor shall provide all traffic control necessary to maintain and protect traffic in conformance with the Contract Documents. The Contractor shall secure the pavement marking operations and protect the markings until they are thoroughly set. All longitudinal pavement markings shall be applied in the direction of traffic. Placing pavement marking material over longitudinal joints is prohibited.

C. Pavement markings shall conform to the following:

1. Temperature. Material shall be applied as specified at the manufacturer's recommended ambient, surface and material temperatures.
2. Thickness. Refer to the Contract Documents for the type of material being applied.
3. Glass Beads. Refer to the Contract Documents.
4. Color. Refer to the Contract Documents for the proper color.
5. Widths. The traveled way lane widths and the width of longitudinal lines shall be as specified in the Contract Documents. Lane widths shall be measured from the center of the line to the center of the line once a control line is established for the lane configuration of the roadway. When measurements are taken from existing longitudinal lines, the point of reference shall be the center of the single line or the center of the space between dual lines. The traveled way lane widths shall be in compliance when they have an acceptable appearance and do not deviate more than two inches (2″) from the proposed lane width.
6. Alignment. Markings shall be placed in a straight and uniform manner. Lane lines shall be in compliance when they have an acceptable appearance, and are visually in alignment, with no more than three-eighths inch (3/8″) variation in any forty foot (40′) section of traveled way. Longitudinal alignment shall be maintained through all intersections and breaks, even though the lines themselves may discontinue.
7. Curing. Refer to the Contract Documents.
8. Retro-reflectance. The minimum retro-reflectance of the permanent pavement markings shall be the millicandellas/lux/square meter values specified in the Contract Documents. The retro-reflectance of the pavement markings shall be determined using a calibrated fifteen (15) m or thirty (30) m geometry retro-reflectometer supplied by the Contractor and tested as specified in Maryland Standard Method of Tests (MSMT) 729. An average of five (5) readings shall be used at each site to determine conformance with the Contract Documents and as specified in Maryland Standard Method of Tests (MSMT) 729. The retro-reflectometer shall be calibrated annually by the manufacturer and a copy of the

calibration certification shall be submitted to the Engineer for that project. The instrument shall be standardized daily in conformance with the manufacturer's recommendations.

9. Layout Markings. Any layout markings that detract from the overall appearance or function of the final markings as determined by the Engineer shall be removed at no additional cost to the City.
10. Empty Containers. The Contractor shall remove and dispose of all empty containers and other debris related to the pavement marking operation from the project site.

D. Noncompliance with the Contract Documents during the pavement marking operation shall be just cause to suspend the operation. A meeting shall be held to review the quality control plan to assure that continued operations will be in compliance. Areas of noncompliance will be identified by the Engineer and correction will be as defined in the quality control plan. Any incorrect markings shall be completely removed by corrective actions.

3.4 QUALITY CONTROL TEST STRIP

Before beginning Work with each color, the Contractor shall place a two hundred foot to three hundred foot (200′ to 300′) cumulative quality control test strip of pavement marking material that conforms to the Contract Documents at a location to be determined by the Engineer. Additional control strips may be required at the Engineer's discretion. Authorization to proceed will be given when the Contractor demonstrates to the Engineer that the quality control test strip conforms to the Contract Documents.

3.5 CURING

The Contractor shall protect the markings until dry or cured by placing warning devices as specified in the Contract Documents and as approved by the Engineer. In the event that the uncured marking is damaged by a vehicle, the marking shall be reapplied, and marks left on the pavement by the vehicle shall be removed. This Work shall be performed at no additional cost to the City.

3.6 OBSERVATION PERIOD

A. The Contractor shall be responsible for any defects in materials and workmanship of the pavement markings for a period of one-hundred eighty (180) days for durable materials and sixty (60) days for nondurable materials from the date the pavement is opened to traffic.

B. During the observation period, the permanent pavement marking material shall show no signs of failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, chipping, spalling, poor adhesion to the pavement, or loss of reflective beads.

C. A minimum of ninety-five percent (95%) of the applied markings shall remain intact during the observation period as determined by the Engineer.

D. When required, removal of pavement markings shall be performed by the Contractor with no damage to the pavement surface. Any damage incurred shall be the responsibility of the Contractor to repair or replace the pavement surface as determined by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all pavement preparation, furnishing and placing of markings, testing, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Permanent pavement markings and the removal of existing pavement markings will be measured and paid for at the Contract Unit Price for one or more of the following items:

1. Permanent Pavement Markings will be measured and paid for at the Contract Unit Price per linear foot for the color and widths specified.
2. Permanent Pavement Marking Letters, Symbols, Arrows, and Numbers will be measured and paid for at the Contract Unit Price per each.
3. Removal of Existing Permanent Pavement Markings will be measured and paid for per stripe at the Contract Unit Price per linear foot, regardless of width.
4. Removal of Existing Permanent Pavement Marking Letters, Symbols, Arrows, and Numbers will be measured and paid for at the Contract Unit Price per each.

C. Removal, Replacement, or Corrective Actions. Any additional cost (including Maintenance of Traffic) for the removal of markings that are incorrectly or inaccurately installed or failed the observation period, shall be at no additional cost to the City. In addition, the current road user's fee will be applied when traffic disruption occurs during corrective actions.

32 17 23.14 TEMPORARY PAVEMENT MARKINGS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, installing and removing temporary pavement markings as specified in the Contract Documents or as directed by the Engineer. These markings shall include lines, letters, numbers, arrows and symbols.

PART 2 PRODUCTS

2.1 MATERIALS

A. Removable Preformed Pavement Marking Material shall conform to the Contract Documents.

B. Nontoxic Lead Free Waterborne Pavement Markings shall conform to the Contract Documents.

PART 3 EXECUTION

3.1 QUALITY ASSURANCE/QUALITY CONTROL

Quality control testing shall be completed by the Contractor's certified technicians. The Engineer will complete the quality assurance checks in conformance with Maryland Standard Method of Tests 729 by performing the Nighttime Visibility Evaluations.

3.2 WARRANTY PERIOD

The Contractor shall maintain and be responsible for any defects in the pavement markings for a period of one-hundred eighty (180) days from the date of application. The Contractor shall replace the pavement markings as necessary within this period as directed by the Engineer at no additional cost to the City. The Contractor shall be responsible for repair of all traffic damages to the Work, either partially or totally completed, until such time as the Work is accepted by the City. Responsible, as used here, shall mean the responsibility for restoration and the cost thereof unless otherwise expressly provided for in the Special Provisions.

3.3 APPLICATION AND REMOVAL

A. The pavement markings shall be applied in conformance with the manufacturer's recommendations and the Contract Documents. Markings shall be applied in the same direction as the flow of traffic. The markings shall be located as specified in the Contract Documents or as directed by the Engineer.

B. Pavement markings may be applied to either new or existing paved surfaces. When applied to newly paved surfaces, the markings shall be placed before traffic is allowed on the pavement. Nontoxic lead free waterborne pavement markings shall be used for all temporary pavement markings except for the final surface. However, the Contractor may use removable preformed pavement markings at no additional cost to the City.

C. When at the "end of season", the temperatures are too low to allow the placement of removable tape on the final surface, a written exception request may be submitted to the Engineer to allow the use of nontoxic lead free waterborne paint in lieu of removable tape until the following striping season.

D. When it is appropriate to shift lanes, all nonapplicable pavement markings within the travel way and adjacent to the travel way as directed by the Engineer shall be completely removed.

E. Surface Condition. Prior to application of pavement markings, the pavement surface shall be clean, dry and free of all contaminants, including curing compound, dirt and loose particles. Residual pavement markings shall be removed. Loose or poorly constructed markings shall also be removed.

F. Pavement Marking Removal. All removable preformed pavement markings shall be completely removed prior to application of the permanent markings. On stage Construction or final surfaces of portland cement concrete pavements, any objectionable adhesive residue shall be removed by water blasting or other methods as may be approved by the Engineer. Open flame is prohibited to remove adhesive residue or any pavement markings. The Contractor shall remove all nonapplicable pavement markings so that there is no damage to the existing or final surface.

G. Retro-reflectance. The initial retro-reflectance readings for temporary pavement markings shall be a minimum of two-hundred fifty and one-hundred fifty (250 and 150) millicandellas/lux/m^2 for white and yellow, respectively. The Engineer will monitor the pavement markings in conformance with Maryland Standard Method of Tests (MSMT) 729 during the Contractor's one-hundred eighty (180) day period of responsibility.

PART 4 MEASUREMENT AND PAYMENT

A. Payment for Removable Preformed Pavement Markings, Removal of Removable Preformed Pavement Markings, Nontoxic Lead Free Waterborne Pavement Marking Paint and the Removal of Existing Pavement Markings will be measured and paid for using one or more of the items below and as specified in the Contract Documents.

B. The payment will be full compensation for furnishing, placing, complete removal of lines, letters, numbers, arrows, symbols and the removal of all residues. In addition, payment will cover maintenance and replacement during the one-hundred eighty (180) day period and for all material, labor, equipment, tools and incidentals necessary to complete the Work. Removal and replacement of temporary pavement markings required beyond the one-hundred eighty (180) day period will be measured and paid for at the Contract Unit Price for the pertinent temporary pavement marking item.

C. Temporary markings replaced during the one-hundred eighty (180) day period as a result of plowing (as determined by the Engineer) will be paid for at the Contract Unit Price for the pertinent temporary marking item.

1. Nontoxic Lead Free Waterborne Pavement Marking Paint per linear foot.
2. Removable Preformed Pavement Line Markings per linear foot.
3. Removable Preformed Letters, Symbols, Arrows and Numbers per each.
4. Removal of Removable Preformed Pavement Markings, any width, per linear foot.
5. Removal of Removable Preformed Letters, Symbols, Arrows and Numbers per each.
6. Removal of Existing Pavement Line Markings, any width, per linear foot.
7. Removal of Existing Letters, Symbols, Arrows and Numbers per each.

32 17 23.24 TEMPORARY RAISED PAVEMENT MARKERS (RPMs)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, installing and removal, as necessary, of temporary raised pavement markers as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Temporary RPMs shall conform to the approved list maintained by the Engineer.

PART 3 EXECUTION

All material, labor, equipment, tools and incidentals necessary for the complete installation of temporary RPMs, as specified in the Contract Documents, shall conform to the manufacturer's recommendations.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Increases or decreases in quantities will not be a basis for renegotiation of the Contract Unit Price.

1. Temporary Raised Pavement Markers will be measured and paid for at the Contract Unit Price per each.
2. Removal of Temporary Raised Pavement Markers will be measured and paid for at the Contract Unit Price per each.
3. The City will reimburse the Contractor at the Contract Unit Price per each marker damaged by snowplow operations.

32 31 00 FENCES AND GATES

32 31 13 CHAIN LINK FENCE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and erecting chain link fence as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Mix No. 2. Concrete Mix No. 2 shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

B. Fence Fabric shall conform to the following: Chain link fencing fabric shall be two inch (2″) mesh woven from coated No. 6 gauge wire for six foot and eight foot (6′ and 8′) fence and No. 9 gauge wire for five feet (5′) fence unless otherwise specified in the Contract Documents. The ends shall have a knuckled selvage at the bottom and a barbed selvage at the top. The fabric shall conform to M 181. Type I fabric shall conform to Class D coating. Vinyl coated steel shall conform to F 668, Class 2B thermally fused. Vinyl color shall be warm gray or black as specified in the Contract Documents.

C. Tie Wires, Line Post Clips, Tension Wires and Tension Wire Clips. These items shall conform to M 181. The galvanized coating shall have a minimum weight of one and two-tenths (1.2) oz/ft^2. These items, when used with aluminum coated steel fabric, shall be coated with aluminum at a minimum weight of four-tenths (0.40) oz/ft^2. The tension wire used with polyvinyl chloride (PVC) coated steel fabric shall have the same coating thickness and color requirements as the fence fabric.

D. Posts, Braces, Fittings and Hardware. All posts, braces, fittings and hardware shall conform to M 181. When these items are specified to be PVC coated, they shall be thermally fused and bonded. The PVC thickness shall be ten to fifteen (10 to 15) mil

except that bolts, nuts and washers shall be metallic coated steel. When opting to use round posts, the posts shall conform to industry standards for Class 1 or 2.

E. Gates. The fabric used for gates shall be identical to the fencing fabric. The gate frame and other hardware shall conform to paragraphs 2.1C and 2.1D. When the gate frame is PVC coated, movable fittings, such as hinges and latches, shall be field coated with a PVC coating specifically prepared for this purpose.

F. Barbed Wire. Barbed wire shall conform to A 121. The barbed wire shall be twelve and one-half (12-1/2) gauge with four (4) point, round barbs at five inch (5″) spacing and Class 3 coating requirements.

2.2 TYPE OF FENCE

A. The height and type of fence shall be as specified in the Contract Documents. When the type of fence is not specified, one of the following types may be used:

1. Galvanized steel and malleable iron components.
2. Galvanized steel fabric utilizing galvanized steel posts or aluminum line posts.
3. Aluminum coated steel fabric utilizing galvanized steel line posts.
4. Aluminum coated steel fabric utilizing aluminum line posts.
5. Bonded vinyl coated fabric utilizing galvanized steel or galvanized bonded vinyl coated steel line posts and fittings.
6. Bonded vinyl coated fabric utilizing aluminum line posts.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. The Contractor's activities and operations shall be confined to the area immediately adjacent to the right-of-way lines and within the right-of-way except that permission may be granted by the Engineer for normal Construction activities through lands owned by or under control of the City.

B. In areas where any privately owned fence or other property is within the City's right-of-way, the Contractor shall remove the items and place them on the owner's property as directed by the Engineer. The Contractor shall be held responsible for any damage to privately owned items removed.

C. Fence lines specified in the Contract Documents are only a guide and the exact location of the fence shall be determined in the field by the Engineer.

D. The bottom of the fabric shall be placed a nominal distance of one inch (1″) above the ground line. A maximum clearance of six inches (6″) will be permitted for a maximum horizontal distance of eight feet (8′) except for special conditions as specified in the Contract Documents.

E. Any excavation or backfill required to comply with the above clearance shall be as approved by the Engineer. Fence fabric shall be placed on the roadside of the posts. For storm water management ponds, the fabric shall be placed on the outside of the posts or the side farthest from the pond.

F. The fence shall be true and taut.

G. All posts shall be plumbed and spaced as uniform as practicable to the spacing specified in the Contract Documents with a tolerance of plus or minus two feet (± 2′).

H. Terminal posts shall be installed at all ends, abrupt changes in grade and at changes in the horizontal alignment over fifteen degrees (15 °). The maximum distance between terminal posts shall be five hundred feet (500′).

I. Post lengths shall accommodate the fabricated width of the fence fabric without stretching or compressing the fabric and provide the required spacing below the bottom of the fabric.

J. Post caps are required for all round line, terminal and corner posts.

K. A tension wire shall run continuously between terminal posts near the top and bottom of the fabric and attached to the fabric with hog ring fasteners at eighteen inch (18″) intervals.

L. Horizontal brace rails with diagonal truss rods and turn buckles shall be installed at all terminal posts. Sufficient braces shall be supplied to permit complete bracing from each terminal post to all adjacent line posts.

M. Fabric shall be tied to brace rails at two feet (2′) maximum intervals and to posts at twelve inches (12″) maximum spacing. Stretcher bars shall be attached to terminal posts by connectors equally spaced at sixteen inches (16″) maximum centers. Top and bottom connectors shall be as close as possible to the ends of the fabric.

3.2 ANCHORAGE FOR LINE POSTS AND TERMINAL POSTS

A. All posts shall be plumb. The Contractor shall select the type of anchorage system from the following except when rock is encountered only the concrete method shall be used.

B. Rock. Where rock is encountered at a depth less than that specified for the footing, a hole one inch (1″) larger than the greatest dimension of the post shall be drilled to a depth of twelve inches (12″) or the planned footing depth, whichever is less. After the post has been set, the remainder of the drilled hole shall be filled with grout composed of one (1) part portland cement and two (2) parts mortar sand by dry loose volume. The space above the rock shall be filled with concrete. The anchor unit method is prohibited in rock areas, where all posts shall be set in concrete.

C. Concrete Method. Posts shall be centered in the concrete footings. The concrete shall be thoroughly compacted around the post by rodding or vibrating. The finished top surface shall be troweled to a smooth finish slightly above the ground line and uniformly sloped to drain away from the post. The post shall not be disturbed within the seventy-two (72) hours after the individual post footing is completed.

D. Hand mixed concrete shall not be used unless otherwise approved by the Engineer. When permitted, the maximum size of the hand mixed batch shall be one-half (1/2) yd^3.

E. Drive Anchor Blade Method. Drive anchor blades consist of two (2) steel blades driven diagonally through galvanized steel fittings attached to opposite sides of the posts. After being driven into the ground, the post shall be held rigidly upright by means of a drive anchor blade unit. The approximate spread of the blades at their full depth shall be thirty-nine inches (39″). The top of the device shall be a minimum of three inches (3″) below the finished grade. The anchor unit device and procedure shall be as approved by the Engineer.

F. Each line post shall be anchored by one of these units and each terminal post shall be anchored by two (2) units spaced approximately six inches (6″) apart. Each drive anchor blade unit for the terminal post shall be driven in a direction to offset the stresses caused by the tension of the fence.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. The removal of privately owned fence or other property from within the City's right-of-way will not be measured but the cost will be incidental to the Contract lump sum price for clearing and grubbing.

C. When an item for Clearing and Grubbing is not specified in the Contract Documents, clearing and grubbing will not be measured but the cost will be incidental to the Contract Unit Price for the pertinent chain link fence item.

D. Chain Link Fence will be measured and paid for at the Contract Unit Price per linear foot for the actual number of linear feet measured to centers of end posts.

E. Terminal Posts (End, Pull and Corner Post) will be measured and paid for at the Contract Unit Price per each for the size and type specified.

F. Gates will be measured and paid for at the Contract Unit Price per each as complete units of the size and type specified.

32 31 23.10 TEMPORARY ORANGE CONSTRUCTION FENCE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing new or like new, temporary orange mesh Construction fence. The fence shall be used where specified in the Contract Documents or where directed by the Engineer. This fence is not a safety barrier.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast Concrete Blocks. Solid concrete masonry block shall conform to C 139.

B. Tension Wire, Tie Wires, Clips and Hardware. These items shall conform to M 181. The galvanized coating shall have a minimum weight of one and two-tenths (1.2) oz/ft^2. These items, when used with aluminum coated steel fabric, shall be coated with aluminum at a minimum weight of four-tenths (0.40) oz/ft^2. The tension wire used with polyvinyl chloride (PVC) coated steel fabric shall have the same coating thickness and color requirements as the fence fabric.

C. Orange Mesh Fencing shall be as approved by the Engineer.

D. Fence posts shall be four feet (4′) high round posts having one and nine-tenths inches (1.90″) outside diameter, or a five and one-half feet (5-1/2′) high, two inch (2″) steel U channel.

E. Samples of the fence fabric, fence posts, movable precast concrete blocks, tie wire, tension wires and other miscellaneous hardware shall be submitted to the Engineer prior to installing any fencing.

PART 3 EXECUTION

A. Temporary orange construction fence shall be a minimum of four foot (4′) high with a maximum post spacing of eight feet (8′). When the fence is installed on a paved surface, a precast concrete block shall be used to support the round fence post. The concrete block shall have a round hole through the center of the block in which the round post shall be inserted. When the fence is installed in unpaved areas, steel U channel fence posts shall be driven one and one-half feet (1-1/2′) into the ground.

B. The fence fabric shall be attached to the posts using tie wire. Fabric shall be secured to the posts by wrapping a tie wire around the horizontal fence strands and the posts. A top tension wire shall be used to prevent sagging. When installed on paved surfaces, the Engineer will determine if a bottom tension wire is required. The Contractor may elect to install the construction fence in another manner if approved by Engineer.

C. Damaged Construction Fence. Damaged construction fence shall be repaired or replaced within four (4) hours after the Contractor is notified. When the Engineer determines that the fence is no longer needed, the Contractor shall remove the fence, which shall become the property of the Contractor.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for the installation, removal, maintenance, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Temporary Orange Construction Fence will be measured and paid for at the Contract Unit Price per linear foot for the actual number of linear feet measured to the centers of end posts.

C. Remove and Reset Temporary Orange Construction Fence will be measured and paid for at the Contract Unit Price per linear foot.

32 32 00 RETAINING WALLS

32 32 13 CAST-IN-PLACE CONCRETE RETAINING WALLS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of the Construction of cast-in-place reinforced concrete footings and stems conforming to the American Association of State Highway and Transportation Officials (AASHTO) definitions of rigid retaining walls. The retaining wall shall be constructed as shown in the Contract Documents. Included in the retaining wall shall be

all anchorage assemblies for mounting noise barriers when retaining wall mounted noise barriers are specified in the Contract Documents. All components shall be as specified unless prior approval for alternatives is obtained from the Engineer.

B. When piles or drilled shafts (caissons) are specified in the Contract Documents, they shall conform to Sections 31 62 00, (Driven Piles) and 31 64 16, (Drilled Shafts—Caissons) respectively.

1.2 PREAPPROVED ALTERNATE RETAINING WALLS

A. Alternate retaining walls shall only be used when specified in the Contract Documents. When alternate retaining walls are included in the Contract Documents, only those retaining walls specified will be permitted, and only one (1) type retaining wall shall be used throughout the Contract.

B. Alternate retaining walls are selected from the list of preapproved alternate retaining walls, which is maintained by the Engineer. Procedures for adding products to the prequalified list may be obtained from the Engineer.

1.3 CONTRACT DOCUMENTS FOR PREAPPROVED ALTERNATES

A. When the Contract Documents permit and the Contractor elects to use preapproved alternate retaining wall systems, substitute Plans, design calculations, and Specifications shall be submitted by the Contractor. The Plans shall be similar in size and detail to advertised documents, and shall include drainage details and all revisions required to construct the alternate retaining wall system. All Plans, calculations, and Specifications shall be prepared, signed, and sealed by a professional engineer registered in the State of Maryland who has experience in design of the proposed alternate retaining wall system. The substitute Plans shall bear the City's title block and be furnished on reproducible paper. These Plans will be issued as a Contract revision replacing the Engineer's Plans and be kept by the City as permanent records. All Work pertaining to Contract Documents for preapproved alternates shall be done at no additional cost to the City.

B. After substitute Plans are approved and issued as a redline revision, Working Drawings bearing the fabricator or supplier's title block shall be submitted for review and approval to the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Refer to Division 03 30 00, paragraph 2.1.

B. When retaining wall mounted noise barriers are specified in the Contract Documents, the anchorage materials shall conform to the following.

1. Plate shall conform to A 36.
2. Rods shall conform to F 1554, Grade 55, S1 (Chemical Composition and Carbon Equivalent).
3. Nuts shall conform to A 563.
4. Washers shall conform to F 436.
5. Steel Posts (Including plates and shapes) shall conform to A 709, Grade 50W.

2.2 SAMPLE PANEL

A. Whenever the Contract Documents specify that the retaining wall shall include an architectural finish, a sample panel measuring twenty-four inches by twenty-four inches (24″ X 24″) shall be prepared and delivered to the Construction site. The panel shall be typical of the architectural finish and stain to be used on the project. The Engineer's approval of the panel shall be received before full-size retaining walls are constructed. The sample panel shall remain on the project site and all subsequent retaining wall sections shall be equal in appearance to this approved panel.

B. Some projects may require a specified surface such as an ashlar stone pattern, or matching a similar structure or stonework in the area. The Contractor may request or the Engineer may direct that the sample of the texture be submitted for approval prior to submission of the sample panel containing the stain specified in the Contract Documents.

2.3 REINFORCEMENT

Reinforcement bars and welded wire fabric in retaining walls that are less than ten feet (10′) from the edge of paved surface (includes shoulders) shall be epoxy coated. Supports for epoxy coated reinforcement shall be coated the same as the reinforcing steel.

2.4 BACKFILL FOR PREAPPROVED ALTERNATES

Size No. 57 stone shall be used for backfill for all preapproved alternate retaining walls regardless of the type backfill recommended or specified by the retaining wall manufacturer. Geotextile shall be used when specified in the Contract Documents.

2.5 CONCRETE STAIN

When a color is specified in the Contract Documents for the exposed surfaces of the retaining wall, the stain shall be selected from the prequalified list of concrete stains maintained by the Engineer. The color number shall conform to federal standards.

2.6 TEXTURES

1. Unless otherwise specified in the Contract Documents, the exposed surfaces of the retaining wall shall receive a special surface treatment as specified in the following:

    a. Special Surface. Fins and projections shall be removed. The surface of the concrete shall then be saturated with water and kept wet for a minimum of two (2) hours. A grout mix of the same proportions as the concrete shall be thoroughly rubbed onto the surface by sections using burlap pads or cork floats completely filling all voids, pits, and irregularities. After this grout has dried sufficiently, the excess shall be wiped off with dry, clean burlap. The surface shall then be cured as specified in the Division 03 30 00, (Portland Cement Concrete Structures), except that only colorless liquid curing compound shall be used in this method. The exterior faces of cast-in-place superstructures and end posts for bridges over highways and all interior faces of cast-in-place parapets, bridge median barriers, and end posts shall receive this type of finish. This finish shall not be applied to members that have been constructed by the slip form method.

2. When a special texture is specified in the Contract Documents, it shall be produced by placing an approved form liner in the face of the form.

PART 3 EXECUTION

3.1 GENERAL

A. Retaining walls shall be constructed as shown on the Plans, as specified in 03 30 00, Part 3, (Portland Cement Concrete Structures) and herein. Alternate retaining walls shall be constructed in conformance with the details, Specifications, etc. that are on file with the Engineer. Should any detail, Specification, etc., change, the retaining wall firm shall submit the revision for review and approval prior to using that revision on City projects. Revisions shall not be submitted for projects that are already Bid.

B. Loads are not permitted (backfill, noise barriers, concrete traffic barriers, light standards, etc.) on retaining wall concrete until the concrete in that portion has attained a minimum compressive strength of three thousand (3000) psi. Retaining walls shall be backfilled prior to placing these loads on them.

3.2 CONCRETE STAIN

When specified in the Contract Documents, two (2) coats of concrete stain shall be applied in conformance with the manufacturer's recommendations and as directed by the Engineer. Before application of the stain, all surfaces shall be structurally sound, clean, dry, fully cured, and free from dust, curing agents or form release agents, efflorescence, scale, or other foreign materials.

3.3 GALVANIZING

When anchorage assemblies are required for mounting noise barriers, light standards, etc., all holes and welding required in the assemblies shall be done before galvanizing. All assemblies shall be free of oil or any mill coating.

PART 4 MEASUREMENT AND PAYMENT

A. Retaining walls will not be measured but will be paid for at the Contract lump sum price for the pertinent retaining wall item. The payment will be full compensation for all piles and caissons (unless specific items are included in the Contract Documents), footings, forms and form removal, architectural treatment, reinforcement steel, concrete, curing, anchorage assemblies, stains and coatings, excavation, sheeting and shoring, backfill (including size no. 57 stone and geotextiles for alternate retaining walls) and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. When specific items for Piles for Retaining Walls are included in the Contract Documents, they will be measured and paid for as specified in the 31 62 00, Part 4, (Driven Piles).

C. When specific items for drilled shafts (caissons) for retaining walls are included in the Contract Documents, they will be measured and paid for as specified in 31 64 16, Part 4, (Drilled Shafts-Caissons).

32 35 00 SCREENING DEVICES

32 35 16 NOISE BARRIERS

PART 1 GENERAL

1.1 DESCRIPTION

A. The Standard Noise Barrier System shall consist of precast concrete panels, steel or concrete posts, concrete foundations, fire hose connections, doors, and hardware necessary to construct a noise barrier as specified in the Contract Documents. The Contractor has the option of supplying steel or concrete posts, but the same type of post shall be used throughout an entire noise wall. All components shall be as specified unless prior approval for alternatives is obtained from the Engineer.

B. When drilled shafts (caissons) are specified in the Contract Documents, they shall conform to 31 64 16, (Drilled Shafts—Caissons).

C. Bidders may view samples of the proposed panel finishes by contacting the Engineer.

1.2 SPECIAL BIDDING INSTRUCTIONS

When the Contract Documents permit optional post spacing, the Contractor shall place the Bid in the appropriate items for the post spacing selected. Only the items pertaining to the selected post spacing shall be Bid. All remaining items pertaining to the alternate post spacing not selected shall be filled in as zero dollars ("$0.00"). Only one (1) alternate post spacing shall be Bid per wall.

1.3 PREAPPROVED ALTERNATE NOISE BARRIERS

A. Alternate noise barriers shall only be used when specified in the Contract Documents. When alternate noise barriers are included in the Contract Documents, only those noise barriers specified will be permitted, and only one (1) type of noise barrier shall be used per wall.

B. Alternate noise barriers are selected from the list of preapproved alternate noise barriers, which is maintained by the Engineer. Procedures for adding products to the prequalified list may be obtained from the Engineer.

1.4 CONTRACT DOCUMENTS FOR PREAPPROVED ALTERNATE SYSTEMS OR ALTERNATE POST SPACING

A. When the Contract Documents permit and the Contractor elects to use preapproved alternate noise barrier systems or alternate post spacing not shown on the Plans, the City will furnish substitute Plans and Specifications to the Contractor after issuing Notice to Proceed.

B. The substitute Plans may include other pertinent modifications and aesthetic changes necessitated by the Contractor's selection such as requiring tapered panels, higher panels, etc., if the changes in elevation between adjacent panels are determined to be too severe. No additional compensation will be given to the Contractor due to revisions detailed in the substitute Plans and Specifications.

C. The substitute Plans will be issued as a Contract revision replacing the advertised Plans. All Work under this section including any changes required in grading, drainage, paving, utility locations, permits, etc., which is a direct result of the substitute Plans shall be done at no additional cost to the City.

PART 2 PRODUCTS

2.1 GENERAL

After substitute Plans are issued as a redline revision, Working Drawings bearing the fabricator or supplier's title block shall be submitted for review and approval directly to the Engineer as directed by 01 33 21, Contract Documents, Working and shop Drawings and product data.

2.2 MATERIALS

A. Reinforcement for Concrete Structures shall conform to 03 21 00, Part 2, (Reinforcing Steel).

B. Concrete Stain shall conform to 32 32 13, Part 2, (Cast-in-Place Concrete Retaining Walls).

C. Concrete shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

D. Pretensioning Strand, one-half inch (1/2") diameter, seven (7) wire bright and shall conform to M 203, Grade 270, low relaxation strand.

E. Elastomeric Bearing Pads: Elastomeric bearing pads shall conform to the material requirements described in the AASHTO Standard Specifications for highway bridges. The elastomeric bearing shall be sixty (60) durometer hardness, Shore Type A. Accompanying the certificate for elastomeric bearing pads shall be two (2) standard ASTM tensile slabs molded from the same compound batch as the furnished elastomeric bearings.

1. The static load deflection of any layer of elastomeric bearing pads shall not exceed seven percent (7%) at eight hundred (800) psi average unit pressure when tested under Laboratory conditions.
2. The design load for the elastomeric bearing pads will be specified in the Contract Documents. The manufacturer shall proof load each steel reinforced bearing design with a compressive load of one and five-tenths (1.5) times the maximum design load and shall specify that the material conform to the material certification.
3. When test specimens are cut from an actual bearing pad, a reduction of ten percent (10%) in the minimum requirements for original tensile strength and ultimate elongation will be required.

F. Elastomeric Shims: Shims for noise barrier installation shall be either neoprene or composite elastomer with a durometer of sixty (60) plus or minus five (± 5) (Shore A) value.

G. Fusion Bonded Polyester Coating, Color shall be as specified for stain on highway side of roadway and shall conform to 05 05 13.01, Part 2, (Fusion Bonded Powder Coatings for Metals).

H. Anchor Assembly Plate shall conform to A 36.

I. Rods shall conform to F 1554, Grade 55, S1, (Chemical Composition and Carbon Equivalent).

J. Nuts shall conform to A 563.

K. Washers shall conform to F 436.

L. Steel Posts (Including Plates and Shapes) shall conform to A 709, Grade 50W.

M. Fire hose connections, fire doors, miscellaneous hardware, etc. shall be as specified in the Contract Documents.

N. Hardware: No material substitutions will be permitted for anchor rods, nuts, and washers. These items shall be hot dip galvanized in conformance with A 153.

O. Epoxy Zinc Rich Primer: The polyester coater shall provide an epoxy zinc rich primer to be used prior to the application of the polyester powder coating. The material shall withstand temperatures used for the polyester powder coating process and shall be subject to the approval of the Engineer.

P. Precast Concrete Panels: Each panel shall be cast with an embossed or impressed, legible and unique identification number located on a portion of the panel that will not be visible in the completed structure. Panels will be rejected at any phase if identification numbers appear to have been tampered with or altered in any manner. The concrete mix shall conform to Mix No. 6, except that the coarse aggregate shall be AASHTO size no. 5 washed quartz gravel and the design compressive strength shall be five thousand (5000) psi.

1. Textures: All panel surfaces shall be considered as having architectural finishes and care shall be taken to produce a consistent, high quality finish. When stacked panel systems are used, the Contractor shall take extreme care to ensure that the panels stacked within a single frame match in quality and appearance. Aesthetic inspections for all panels shall be made in outdoor lighting conditions. Panels failing to conform to these requirements may be rejected.
2. Special care shall be taken to prevent cement laden spray and spatter created from the process of exposing the aggregate from adhering to the finish surfaces of other panels. Surfaces of all panels shall be washed to remove cement laden spray, dust, and all other foreign matter prior to shipping. Abrasive blasting is not an acceptable method for exposing the aggregate.
3. Unless otherwise specified in the Contract Documents, the finish for the panels shall be as follows:

    a. An exposed aggregate finish shall be produced on the bottom side of each panel in the precast form.
    b. A double rake shall be produced on the top side of each panel.

4. Sample Panels: Two (2) sample panels, each twenty-four inches by twenty-four inches (24″ X 24″) and a maximum of two inches (2”) thick, shall be prepared and delivered to the Construction site. One panel shall represent the residential side (exposed aggregate) and the second panel shall represent the highway side (double rake with stain) except that the stain shall be omitted from the sample. The exposed aggregate panels shall exhibit the color range and exposure of the gravel. The double rake panels shall display the appropriate finished texture. The

Contractor shall notify the Engineer at least one (1) week prior to the delivery of the sample panels. The Engineer's approval of these panels shall be received before full-size panels are manufactured. Whenever the original sample panels are rejected, additional sample panels shall be submitted until the finish is approved.

5. After the sample panels and Working Drawings are approved by the Engineer, a full-size panel shall be prepared for visual inspection and approval by the City at the precasting site. This panel shall have the textures specified in (a) and (b) above on the appropriate highway and residential sides. This panel shall be made available outdoors with both sides visible for inspection. Upon approval by the Engineer, all subsequent panels shall be equal in appearance to this approved panel. This panel shall be transported to the project site and used as one of the panels in the noise barrier after all other panels have been accepted.
6. Reinforcement: Reinforcement bars and welded wire fabric in concrete wall panels that are less than ten feet (10′) from the edge of paved surfaces (includes shoulders) shall be epoxy coated. Supports for epoxy coated reinforcement shall be coated the same as the reinforcement steel.

Q. Concrete Posts: Concrete shall conform to Mix No. 6 except that the coarse aggregate shall be AASHTO size no. 5 washed quartz gravel, and the design compressive strength shall be five thousand (5000) psi. When concrete posts include base plates, plates and all hardware shall be galvanized in conformance with A 153.

1. Textures: Unless otherwise specified in the Contract Documents, the finish for the posts shall be as follows:

   a. An exposed aggregate finish shall be produced on the bottom side of each post in the precast form.
   b. A double rake finish shall be produced on the top side of each post.

2. Sample Posts: When concrete posts are used, the Contractor shall submit a twenty-four inch (24″) long sample of the concrete post to the Construction site for approval. The sample shall be submitted with the panel samples as specified in paragraph 2.1 P. The sample post shall exhibit the specified finishes. The Engineer's approval of the post shall be received prior to manufacturing full size posts.

PART 3 EXECUTION

3.1 GENERAL

Refer to 32 32 13, Part 3, (Cast in Place Retaining Wall), for additional requirements for noise barriers mounted on top of retaining walls. All welding shall conform to AWS D1.1.

3.2 GALVANIZING

All holes and welding required in the hardware shall be done before galvanizing. All hardware shall be free of oil or any mill coating. All welds shall be ground smooth, all weld spatter removed, and hardware shall be free of burrs, rust, or other surface imperfections.

3.3 ANCHOR ASSEMBLIES

Anchor assemblies shall be assembled and placed at the elevation and spacing specified in the Contract Documents. Templates shall be used for proper alignment and spacing of all anchor assemblies prior to concrete placement. The threads of the anchors shall be sufficient to provide for a one inch (1″) concrete encasement, leveling nuts, washers, base plate, and a one-half inch (1/2″) minimum protrusion through the top of the top nut when the noise wall is properly installed.

3.4 POSTS

A. All posts shall be erected plumb at the specified alignment, and at the appropriate spacing.

B. Embedded Concrete Posts: When concrete posts are used, they shall be erected with a temporary support system to ensure the vertical and horizontal alignment and specified elevation. Temporary support systems shall include fixed ties between the post being set and a previously set post. The design of the temporary support systems shall be submitted to the Engineer on the concrete post Working Drawings for approval prior to erection. Temporary support systems shall remain in place for a minimum of forty (40) hours after the completion of the concrete placement for the drilled shaft (caissons) which encases the post.

C. Polyester Coated Steel Posts: Steel posts shall be completely fabricated, including base plates and all holes drilled before applying the polyester coating system.

D. All steel posts shall be free of oil and any mill coating. All welds shall be ground smooth, and all weld spatter removed. Steel posts shall be free of burrs, pits, rust, or other surface imperfections.

E. Steel posts and other nongalvanized items shall be abrasive blasted in conformance with SSPC-SP 10 to a surface condition of near white. The cleaned surfaces shall be protected from conditions of high humidity, rainfall, or surface moisture, and shall not be allowed to flash rust. The epoxy zinc rich primer shall be applied and cured at a minimum dry film thickness of three (3) mil prior to the application of the polyester powder coating. The coating process shall ensure that all solvents in the epoxy zinc rich primer are removed prior to the application of the polyester powder coating.

F. When galvanized surfaces are to be polyester coated, the galvanizing shall be roughened with a brush off blast cleaning conforming to SSPC-SP 7 prior to applying the polyester coating.

G. The polyester coating shall be applied as an electrostatically charged dry powder sprayed onto the grounded posts using an electrostatic spray system. The polyester coating thickness after cure shall be six (6) mil, plus or minus two ($\pm$ 2) mil.

H. The total thickness of coating, primer plus polyester coating, shall be seven to twelve (7 to 12) mil.

I. After coating, the posts shall be randomly checked for continuity using a sixty-seven and one-half (67-1/2) volt wet sponge detector to check for holidays, pinholes, and discontinuities. The coating thickness shall be checked with a properly calibrated magnetic gauge. Posts requiring limited repair for minor defects shall be touched up with a liquid touch-up. All

polyester coated posts shall be wrapped to ensure safe arrival at the job site. At the job site and during installation, the utmost care shall be taken to prevent damage to the posts.

3.5 PRECAST CONCRETE PANELS

A. Precast concrete panels shall be constructed as shown in the Contract Documents.

B. The Working Drawings shall provide for all accessories, additional reinforcement steel, materials, and methods which are not specifically indicated, but which are essential for transportation, handling, and installation or Construction of the panels.

C. Working Drawings shall show the size, shape, and location of all panels and shall include complete reinforcement and connection details. When specified by the Contract Documents, the method and sequence of erection, method of plumbing panels and adjusting connections, and the loads and movements due to erection shall be shown on the Working Drawings.

D. All lifting devices or inserts used externally, or installed in the panel, shall have a safety factor of four (4) as determined under the loading conditions anticipated during the course of manufacture, storage, delivery, and erection. All inserts shall be included on the Working Drawings.

E. Defects and Tolerances. Concrete shall be placed in a manner so that there are no cold joints. Cracked panels or panels determined by the Engineer which cannot be repaired or do not conform to the following tolerances shall be rejected and replaced with acceptable panels at no additional cost to the City:

1. Panel dimensions shall be within three-sixteenths inch (3/16″) except for panels with an effective thickness of less than four inches (4″) where the thickness shall be within one-eighth inch (1/8″).
2. Panel squareness for rectangular panels shall not exceed one-half inch (1/2″) as determined by the difference between the two (2) diagonals.
3. Panel surface defects on textured-finished surfaces shall not exceed five-sixteenths inch (5/16″) per five feet (5′).
4. Tongue and groove joints shall be constructed within one-eighth inch (1/8″) of the dimensions shown on the details.

3.6 SHIPPING, HANDLING, AND ERECTION

A. Panels shall be adequately protected by padding or other means to prevent cracking, staining, chipping, or spalling of the concrete during handling, storage, transporting, erection, etc. Panels shall be adequately supported or braced during installation to ensure safety. The bracing or supports shall be maintained until proper alignment and adequate permanent support have been provided. No panel shall be left in an unsafe support condition.

B. When a panel is damaged, it will be evaluated by the Engineer to determine whether or not it can be used. If acceptable by the Engineer, damaged panels shall be repaired in a manner approved by the Engineer.

C. Panels shall be erected centered between posts. Where a panel is not erected within the tolerances assumed in the connection design, the structural adequacy of the installation

will be checked by the Engineer and the connection design shall be modified as required. Changes, other than adjustments within the specified tolerances, shall be made only after approval by the Engineer.

D. The Engineer will inspect the panels again after erection to determine if they have been damaged.

3.7 CONCRETE STAIN

Concrete stain shall be applied prior to backfilling. Two (2) coats of concrete stain shall be applied in conformance with the manufacturer's recommendations and as directed by the Engineer. Concrete stain shall be applied to the top and full height of the noise wall panels but shall not be applied to exposed aggregate surfaces. Before application of the stain, all surfaces shall be defect free, structurally sound, clean, dry, fully cured, and free from dirt, dust, curing agents or form release agents, efflorescence, scale, or other foreign materials.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the Work. Modifications such as an increase or decrease in the size or number of grade beams, drilled shafts (caissons), or retaining walls, special anchorages, conflicts with utilities or other obstructions when the utilities or obstructions were noted in the Contract Documents, or any other modifications required due to the Contractor's selection of an alternate spacing, or a pre-approved alternate noise wall when permitted, will be incidental to the item.

B. Noise Barrier System panels will be measured and paid for at the Contract Unit Price per square foot of wall including posts, panels, architectural and noise absorptive finishes, stains and coatings, base plates, anchor assemblies (except when noise barriers are mounted on retaining walls), Construction templates, temporary supports, doors, fire hose connections, excavation, backfill, and hardware. Measurement will be based on the as-planned dimensions, using the length along the face of the wall times the panel height.

C. Grade Beams will not be measured but will be paid for at the Contract lump sum price, which shall also include excavation, reinforcement, concrete, and backfill.

D. Drilled Shafts (Caissons) will be measured and paid for as specified in 31 64 16, Part 4, (Drilled Shafts—Caissons).

E. Retaining walls will be measured and paid for as specified in 32 32 13, Part 4, (Cast-in-Place Concrete Retaining Walls).

32 90 00 PLANTING

32 90 00.01 PLANTING TREES, SHRUBS, VINES AND SEEDLING STOCK

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and planting trees, shrubs, vines and seedling stock and all plant establishment operations to complete the Work as specified in the Contract Documents or as directed by the Engineer and Tree Protection Expert. Work shall be done to landscape contractor association (LCB) current Specifications and landscape Specifications guidelines.

1.2 PLANTING SCHEDULE

DECIDUOUS MATERIAL			EVERGREEN MATERIAL	
SEASON	CONTAINER GROWN	BALLED AND BURLAPPED	BALLED AND BURLAPPED	CONTAINER GROWN
Spring	3/1–6/15	3/1–4/30	3/15–4/30	3/15–6/15
Fall	8/15–12/15	10/15–12/15	9/1–11/15	8/15–11/15

Bare root plants shall not be planted while in leaf or during periods of freezing weather. No container grown plant material shall be planted if not acclimated to the current weather conditions. No planting will be allowed out of season without the written permission of the Engineer and Tree Protection Expert.

1.3 PESTICIDE APPLICATION

A. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. All pesticide application Work shall be conducted under the supervision of a certified applicator of pesticides (Category III A or VI). Daily pesticide application reports shall be maintained by the Contractor. A completed copy for each day of application shall be provided to the Engineer.

B. The Contractor shall replace any plant material which is killed and prune any plant material which is damaged through any act of negligence by the Contractor in applying and handling of any pesticides on the project.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fertilizer. Refer to 32 92 23, Part 2, (Sodding).

B. Wood Chips. Refer to 31 25 00.01, Part 2, (Erosion and Sediment Control).

C. Plant Materials. Plant materials shall conform to the following:

1. Plants. All plants, unless otherwise specifically permitted, shall conform to the standards of the current edition of "American Standard for Nursery Stock" as approved by the American Standards Institute, Inc.

a. All plant grades shall be those established in the current edition of American Standards for Nursery Stock manual. Only one size per grade will be listed rather than a size range. The one size shall mean the minimum size for that grade and shall include plants from that size up to but not including the next larger grade size.

b. All plants, unless otherwise specifically permitted, shall be nursery grown and shall have been grown within plant hardiness zones 5, 6, 7 or the Virginia portion of zone 8A as recorded in the current edition of "Plant Hardiness Zone Map," prepared by the U.S. National Arboretum, Agricultural Research Service, U.S. Department of Agriculture.

c. All plant materials shall have normal, well-developed branches and a vigorous root system. They shall be healthy plants free from physical defects, plant diseases and insect pests. Plant materials grown in fields or blocks which show evidence of containing any parts of Johnson grass or Canada Thistle will be rejected.

d. Shade and flowering trees shall be symmetrically balanced. Major branches shall not have V shaped crotches capable of causing structural weakness. Trunks shall be free of unhealed branch removal wounds greater than a one inch (1″) diameter.

e. Shade trees shall have a single main trunk. Trunks shall be free of branches below the following heights prior to installation:

REFORESTATION AND LANDSCAPE		**STREET TREES**	
CALIPER inch	HEIGHT ft	CALIPER inch	HEIGHT ft
1-1/2 to 2-1/2	5	2 to 2-1/2	6
3	6	3	7

2. Plant Names. The authority for all plant names shall be the current printing of "Hortus Third", except for Ilex opaca (American Holly), which shall be the current edition of the International Checklist of Cultivated Ilex. Representative samples of every shipment of plant materials shall be labeled as to genus, species and specified size.

a. Approved Varieties of Ilex opaca. When approved varieties of Ilex opaca are specified, the Contractor shall select from the following list of cultivated varieties.

ILEX OPACA	
Female	Male
Miss Helen Patterson Wyetta Jersey Princess Satyr Hill Old Heavy Berry Dan Fenton	Jersey Knight David Leather Leaf

b. The Contractor shall supply ninety percent (90%) female varieties and ten percent (10%) male varieties unless otherwise specified by the Engineer.

3. Plant Inspection. The initial inspection for conformance with these Specifications will be made at the nursery, holding area or job site. The condition of all plant material will be subject to reinspection for the life of the Contract. Inspection and tagging of plant material with a City seal prior to digging will be at the option of the Engineer. Material arriving with broken seals (if tagging is required), broken or loose root balls, mechanical damage, insufficient protection and shriveled or undeveloped roots will be rejected. All container grown plants shall be well rooted, vigorous and established in the size pot specified, shall have well balanced tops for their pot size, and shall not be root bound. All plant materials shall be declared and certified free from disease and insects of any kind as required by law for the necessary interstate or interdistrict transportation.

4. Plant Digging and Handling. All plants shall be dug in conformance with the digging Specifications in the current edition of "American Standard for Nursery Stock," unless otherwise specified.

5. Substitute Plants. No substitutions shall be made without the permission of the Engineer and Tree Protection Expert. In cases where plant materials are not available at the time of planting, the Contractor shall submit, in writing, evidence that the plants are unavailable. The Engineer and Tree Protection Expert will determine a suitable substitution. Street trees shall be approved by the City Arborist.

6. Maryland Plant Dealer's License. All Contractors performing planting Work and suppliers of trees, shrubs, vines, seedling stock, perennials and bulbs shall possess a Maryland Plant Dealer's License as required by the Maryland Plant Disease Control Law of the Annotated Code of Maryland.

a) Out-of-state Contractors may substitute a dealer's license from their home state in lieu of the Maryland license. Contractors not possessing a similar plant dealer's license from their home state shall obtain a license from the Maryland Department of Agriculture.

D. Miscellaneous. Refer to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

3.1 PLANT STORAGE AND HANDLING

A. The Contractor shall provide adequate facilities for the protection, watering and temporary storage of plant material.

B. Balled and Burlapped (B and B). Root balls shall be kept moist at all times. If not planted within seven (7) days after delivery, the root balls shall be covered with mulch or straw and kept watered until removed for planting. Care shall be taken to prevent damage to trunks, branches and roots. The integrity of the root balls shall be carefully preserved.

C. Container. Container material must be kept watered. Care shall be taken to prevent damage to trunks, branches and roots.

3.2 PREPARATION FOR PLANTING

A. The Contractor shall perform all layout, bed preparation and soil amending as follows:

1. Layout: The Contractor shall provide the stakes and stake out the locations of all plants and the outlines of all seedling areas and plant beds as specified in the Contract Documents. No Work shall be started until the locations and outlines are approved by the Engineer and Tree Protection Expert. Outline stakes for reforestation areas shall be spaced thirty feet (30′) apart or as directed by the Engineer. They shall be driven approximately one foot (1′) into the ground and remain as a permanent means of outline identification through the life of the Contract.
2. Plant Bed Preparation: Existing weed growth in planting beds shall be sprayed with glyphosate with wetting agent conforming to the Maryland Pesticide Applicator's Law and to the manufacturer's recommendations. After a minimum of seven (7) days following herbicide application and prior to secondary weed growth, all planting beds shall be mowed to a height of one inch (1″). After mowing, woody material and debris shall be removed. On flat areas and slopes less than four to one (4:1), one inch (1″) of compost, peat moss or other approved organic soil amendments shall be spread over the entire surface of the planting bed and rototilled to provide a depth of six inches (6″) of loose soil. After rototilling, plant beds shall be raked to provide an even planting surface, removing stones greater than three inches (3″) and other foreign material. Plant beds on slopes four to one (4:1) and steeper do not require surface application of sludge or rototilling.
3. Plant Pit Soil Amendments: All plants shall be planted in planting pits. Soil amending shall be confined to the plant pit and the immediate surrounding area. Soil shall not be mixed while in a muddy or frozen condition. Soil clods two inches (2″) or greater shall be pulverized before mixing.

    a. Soil for plants in the Heath Family (Ericaceous plants, i.e., Azaleas, Mountain Laurel, Sourwood, etc.) shall consist of existing soil into which the Contractor shall thoroughly incorporate twenty percent (20%) peat moss by volume. Based on administration soil test reports, the pH of soil shall be corrected by mixing iron sulfate or other soil pH modifiers approved by the Engineer to provide a pH range from four to five (4.0 to 5.0).
    b. Soil for other plants except members of the Heath Family shall consist of existing soil at each planting pit location into which the Contractor shall thoroughly incorporate twenty percent (20%) by volume of compost or other approved organic soil amendments.

4. Plant Pit Dimensions: Plant pit dimensions are based on standard ball and container sizes established by the administration. All plant pit dimensions shall be as specified in the Contract Documents and as follows: See the chart on the following page.

STOCK	HEIGHT	SPREAD	PIT DIMENSIONS	
			DIAMETER (inch)	DEPTH (inch)
Deciduous & Evergreen Shrubs & Trees B & B	—	—	2 times the ball diameter	Equal to ball depth
Deciduous & Evergreen Shrubs & Trees Container Grown	—	—	3 times the container diameter	Equal to container depth
Deciduous Bare Root Shrubs	18 inches	—	18	10
	2 ft	—	20	10
	3 ft	—	24	12
	4 ft	—.	28	12
Vines	SIZE			
	2-1/4 inch Peat Pot		12	6
	3 inch Peat Pot or Container		18	6
	4 inch Container		18	8
	No. 1 Container		18	8

3.3 PLANTINGS

A. The Contractor shall perform all planting, fertilizing, supporting, pruning, mulching and initial watering operations conforming to the following:

1. General: Plants shall be placed in planting pits in a vertical position with the root collars exposed at the proper height as specified below. Amended soil shall be placed under and around roots to stabilize them in position. The root collars shall be placed at the following levels:

TYPE OF SOIL	COLLAR HEIGHT
Well Drained	Same level as the existing grade
Compacted	1 to 2 inches above the existing grade
Wet, Poorly Drained	25 percent of root mass above the existing grade

a. For wet, poorly drained soils, approved topsoil mixed with twenty percent (20%) by volume of compost or other approved organic soil amendments, shall be placed on top of the planting pit and tapered to the existing grade at the edge of the planting pit as specified in the Contract Documents.

b. The burlap on the tops of plant balls shall be loosened and cut away from the entire top portion of the plant ball. When wire baskets are used, they shall be removed at planting. Containers shall be removed from the root mass of container grown plants and the fibrous roots loosened around the perimeter of the ball. Amended soil for all plants shall be lightly compressed to eliminate major air pockets. Planting soil shall be thoroughly saturated with water during the planting process to settle soil, eliminate air pockets and to provide for initial water needs of the plants.

c. During the planting process, fertilizer tablets or other approved slow release fertilizers shall be placed around plant roots in conformance with the manufacturer's recommendations.

d. Care shall be taken during the backfilling, soil compressing and watering to avoid injuring the roots.

e. Individually planted trees and shrubs shall have a four inch (4″) high berm of excavated soil or mulch placed outside the rim of the pit to form a saucer. Plants on slopes four to one (4:1) and steeper shall have soil excavated from the uphill rim of the pit and a berm built on the downhill rim.

f. Plants in beds, except trees, will not require berms. A four inch (4″) high shoulder of excavated soil shall be placed at the lower edge of all beds on slopes four to one (4:1) and steeper.

g. Berms and shoulders for planting shall be compacted and graded to the satisfaction of the Engineer and Tree Protection Expert.

2. Tree Staking and Guying: Shade trees specified at six feet (6′) high, flowering trees specified at three-quarters inch (3/4″) in caliper and evergreen trees specified at five feet (5′) high or greater sizes shall require supports. Other trees shall be supported as specified in the Contract Documents and as follows:

STOCK	CALIPER inches	HEIGHT feet	SUPPORT REQUIRED
Shade Trees	—	6	2 stakes 6 ft length
	3/4 to 2	—	2 stakes 8 ft length
	2-1/2 to 3-1/2	—	3 stakes 10 ft length
	4 and over	—	3 guy wires attached to approved tree anchors
Flowering Trees	3/4 to 2-1/2	—	2 stakes 5 to 8 ft length as required
	3 and over	—	3 guy wires attached to approved tree anchors
Evergreen Trees	—	5 and 6	2 stakes 5 to 6 ft length as required
	—	7, 8 and 9	3 stakes 7 to 8 ft length as required
	—	10 and over	3 guy wires attached to approved tree anchors

a. When driving stakes and installing anchors, trees shall not be damaged. Each stake shall be positioned five inches to eight inches (5″ to 8″) away from the edge of the ball and driven into solid bearing ground to a minimum depth of ten inches (10″) or more below the bottom of the pit to support the plant. After stakes are driven, they shall be vertical. Stakes and guys shall support trees in a vertical position. All tree staking and guying shall be completed the same day as planting.

b. Staking and guying shall be performed as specified in the Contract Documents or as directed by the Engineer.

3. Mulching: All plant beds and pits shall be mulched with approved composted wood mulch or other approved mulches to a minimum thickness of three inches (3″), including soil berms and shoulders. The mulch shall be raked to an even surface to the limits specified in the Contract Documents or as directed by the Engineer.

4. Pruning: All deciduous trees under six feet (6′) high and shrubs shall be pruned after inspection on the site as approved by the authorized Tree Protection Expert, with care being taken to preserve the natural appearance of the plant. Deciduous trees greater than six feet (6′) high shall be pruned before planting.

5. Cleanup: During the course of planting, excess and waste materials shall be promptly removed, the turf areas kept clean and all reasonable precautions taken to avoid damage to existing structures, plants and grass.

3.4 PLANT CARE DURING CONSTRUCTION

Plant care shall begin immediately after each plant is installed and shall continue through the landscape Construction phase as specified in paragraph 3.6. Plants installed according to Article 7, Forest and Tree Conservation, shall have a maintenance period as specified in that legislation or on approved Plans.

3.5 CONSTRUCTION PHASE ACCEPTANCE

A. The Contractor shall submit a request to the Engineer in writing for acceptance of the Construction phase. The Engineer will grant acceptance when the landscape project has been substantially completed and the following requirements are in conformance:

1. Plant materials show evidence of having been successfully transplanted.
2. Unacceptable plants have been replaced.
3. Planting pits and planting beds are weed free.
4. Damaging pests have been controlled.
5. Dead wood has been pruned.
6. Trees have been straightened.
7. Staking and guying have been repaired.
8. Washouts in and around planting pits and beds have been repaired and mulch has been replaced as required.
9. Plants have been watered as necessary.
10. All other required Work has been completed.
11. Landscaping approved by Tree Protection Expert.

3.6 PLANT ESTABLISHMENT

A. The Contractor shall maintain and establish the plants for a period of one (1) year or as specified in Article 7, Forest and Tree Conservation.

1. Beginning: The period of establishment will begin upon the Engineer's acceptance of the Construction phase.
2. Maintenance: The Contractor shall maintain all plants in conformance with the original Specifications and as follows:

    a. Additional Watering of Plants: The Contractor shall monitor the water needs of all plants. When the Contractor feels watering is necessary, the Engineer shall be notified. If the Engineer concurs, the Contractor shall begin watering immediately. If the Contractor fails to water when and as required, the Engineer will notify the Contractor and watering shall begin within -our (24) hours. The Contractor shall continue to water daily until all plant pits in the Contract have been watered unless otherwise directed by the Engineer. Each watering shall be completed within seven Calendar Days (7) of the day on which watering was designated to begin. All watering shall be accomplished using a hose with nozzle end breaker or watering probe. Water shall be applied at low water pressure directly to each planting pit, allowing water to be absorbed into the planting pit soil

until saturated, but without runoff. "Gator bags" may be used to properly distribute water to plants where approved by Tree Protection Expert.

b. Weed Control: All undesirable vegetation growing within mulched areas shall be eradicated using glyphosate with a wetting agent in conformance with the manufacturer's recommendations. During each growing season, the Engineer and the Contractor shall inspect the site on or about May 30, July 15 and August 30 to determine if weed control is acceptable. Eradication shall be performed prior to these inspections. All weeds greater than six inches (6″) high shall be cut down and removed from the project. Any remaining live weed growth shall be treated with herbicide until eradicated. All herbicide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. The Contractor shall provide a Certified Applicator of Pesticides (Category III A or VI). Daily herbicide application reports shall be provided to the Engineer. The Contractor shall be responsible for replacing and pruning any plant material which is killed or damaged through any act of negligence by the Contractor in applying and handling of the herbicide on the project.

c. Pest Management: The Contractor shall institute an integrated pest management (IPM) Program. The Contractor shall periodically inspect the project for plant pests during each growing season. When potential damaging levels of plant pests are observed, they shall be controlled to prevent damage to the plants.

d. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. The Contractor shall provide a Certified Applicator of Pesticides (Category III A or VI). Daily pesticide application reports shall be provided to the Engineer.

e. If the Contractor fails to monitor and control plant pests prior to damage, the Contractor will be notified to begin pest control operations within twenty-four (24) hours, until all damaging pests have been controlled.

f. Refertilization: When required and as directed by the Tree Protection Expert, plants shall be fertilized with a solution of 20-20-20 or other approved analysis water soluble fertilizer designed for the liquid fertilization of plants as specified in the manufacturer's recommendations.

g. Tree Support Removal: The Contractor shall remove all tree supports to ground level after one (1) growing season in conformance with the Contract Documents. Stakes shall be removed by cutting or pulling. All stakes, hoses, wires and guys shall be completely removed from the job site and disposed of by the Contractor. Tree support removal shall be performed in the last thirty (30) days of the plant establishment period and prior to Final Acceptance of the project.

3. Removal and Replacement: The Contractor shall promptly remove from the project all unacceptable plants. Plant replacement shall be made as originally specified. All unacceptable plants shall be replaced during each planting season. When between planting seasons, they shall be replaced during the next proper planting season.

4. Final Acceptance: The Contractor shall submit a written request to the Engineer for a Final Acceptance of the landscaping on the project.

3.7 PLANT RELOCATION

If the Engineer or Tree Protection Expert determines that selected locations of plants installed on the project are undesirable, the plants shall be relocated as directed by the Engineer or Tree Protection Expert. When directed, the Contractor shall begin removing plants within five (5) working days and continue daily relocation operations until Work is complete. Backfilling of abandoned planting pits shall conform to paragraph 3.8.

3.8 ABANDONED PLANTING PITS

When the Engineer directs that an excavated plant pit be abandoned, the Contractor shall backfill the pit with the excavated soil or approved backfill. The backfill shall be compacted in eight inch (8″) layers to the finished grade. Preparation and seeding of the disturbed area shall conform to 32 92 23.01, (Turf Establishment).

PART 4 MEASUREMENT AND PAYMENT

A. Planting trees, shrubs, vines and seedling stock will be measured and paid for at the Contract Unit Price per each item specified in the Contract Documents. The payment will be full compensation for all tree supports, watering during the Construction period and for all material, labor, equipment, tools and incidentals necessary to complete the Work. If at any time during the Contract period any plants become unacceptable, they shall be replaced at no additional cost to the City.

B. Mulching: Composted wood chips or other approved mulching materials within the planting beds will be measured and paid for at the Contract Unit Price per square yard. The measurement will be computed on the surface area of the specified thickness before settling or as directed by the Engineer. The payment will be full compensation for all mulch, material, labor, equipment, tools and incidentals necessary to complete the Work.

C. Additional Watering of Plants: Additional watering of plants will be measured and paid for during the plant establishment period at the Contract Unit Price per one thousand (1000) gallons of water applied to the plants.

D. Plant Relocation: Plant relocation will be measured and paid for at the Contract Unit Price per cubic foot for the specified planting pit. The payment will be full compensation for plant relocating, placing all backfill, seeding of damaged turf and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

E. Abandoned Planting Pits: Abandoned planting pits will be measured and paid for at the Contract Unit Price per cubic foot measured prior to backfilling. The payment will be full compensation for placing all backfill, seeding of damaged turf and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

F. Plant Refertilization: Plant refertilization will be measured and paid for at the Contract Unit Price per one thousand (1000) gallons of liquid fertilizer mixture applied to the plants in conformance with paragraph 4.C. The payment will be full compensation for furnishing fertilizer, water and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

32 91 00 PLANTING PREPARATION

32 91 16.16 SOIL STABILIZATION MATTING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, placing and securing matting on seeded areas, as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Type A Soil Stabilization Matting: Type A soil stabilization matting shall consist of a machine-produced mat of degradable natural or man made fibers. Matting shall be smolder resistant. When a chemical is used, it shall be nonleaching, nontoxic to vegetation and the germination of seed, and noninjurious to the skin. Type A matting shall have a uniform thickness and distribution of fibers throughout. The top and bottom of the matting shall be covered with a degradable extruded plastic netting having a maximum mesh opening of two inches by two inches (2″ X 2″) or covered on the top side with netting machine sewn or bonded on two inch (2″) centers along the longitudinal axis of the material. The average breaking strength of any two (2) strands of netting shall be five (5) lb minimum. The netting shall be entwined with the matting fibers in a manner which shall provide sufficient reinforcement against damage during handling and placement and shall resist degradation for a minimum of six (6) months and a maximum of one (1) year.

B. Type B Soil Stabilization Matting: Type B soil stabilization matting shall consist of a machine-produced mat of nondegradable fibers or elements and have a uniform thickness and distribution of weave throughout.

C. Staples for Type A Soil Stabilization Matting: Staples shall be U or T shaped steel wire having minimum gauges of No. 11 and No. 8, respectively. The U shaped staples shall average one to one and one-half inches (1″ to 1-1/2″) wide. The T shaped staples shall have a main and a secondary leg and four inch (4″) head. For the length of the staples to be used with the Type A matting, refer to paragraph 3.4. For sod, the U shaped staples shall be a minimum length of six inches (6″) and the T staples shall have a main leg length of eight inches (8″) and a secondary leg length of one inch (1″).

D. Staples and Wood Stakes for Type B Soil Stabilization Matting: Fasteners shall be staples or wood stakes. Staples shall be U or T shaped steel wire having minimum gauges of No. 11 and No. 8, respectively. The U shaped staples shall average one to one and one-half inches (1″ to 1-1/2″) wide. The T shaped staples shall have a main and secondary leg and four inch (4″) head. Wood stakes shall be sound, rough sawn, hardwood measuring one inch by three inch (1″ X 3″) at the top. For the length of the fasteners to be used with the Type B matting, refer to paragraph 3.4.

E. Soil stabilization matting shall be supplied in forty to ninety-six inch (40″ to 96″) width rolls. The material shall be selected from the City's prequalified materials list for the use specified.

PART 3 EXECUTION

3.1 GENERAL

When topsoil is specified for areas where matting is to be placed, the Work shall be completed before the soil stabilization matting operation is started. The matting shall be placed within forty-eight (48) hours after seeding operations have been completed. Matting shall be laid smoothly and firmly upon the seeded surface in the direction of water flow. Stretching shall be avoided.

3.2 PLACING AND SECURING TYPE A SOIL STABILIZATION MATTING

A. Where more than one width of matting is required, the strips shall overlap at least two inches (2″). Ends shall overlap at least six inches (6″). The upgrade end of each strip of matting shall be turned down and buried to a depth of not less than six inches (6″) with the soil firmly tamped against it. Overlapping shall be done with the upgrade section on top. The Engineer may require any other edge exposed to more than normal flow of water to be buried in a similar manner. Edges of matting shall be similarly buried around the edges of catch basins and other structures.

B. Matting shall be securely fastened in place with staples driven vertically into the soil and flush with the surface. Staples shall be placed on two feet (2′) centers throughout the mat. Staples shall be placed no more than eighteen inches (18″) apart in the center of the ditch and along the outside edge of the last mat installed. On all overlapping edges, staples shall be placed eighteen inches (18″) apart. At all ends of the matting, staples shall be placed six inches (6″) apart. Mats constructed of wood and hydromulch shall also be watered immediately after stapling to bond the mat with the soil. Water shall be applied so it falls on the mat like a normal rainfall. At no time shall the water be directed from water or a hydroseeder spray gun in a direct straight line to the mat.

3.3 PLACING AND SECURING TYPE B SOIL STABILIZATION MATTING

A. Matting shall be installed to preclude a longitudinal joint. A longitudinal joint may be installed if approved by the Engineer. Matting shall be securely fastened in place with either staples or wood stakes (fasteners) driven vertically into the soil. Staples shall be driven flush with the matting and wood stakes shall be driven so three inches (3″) is left above the matting. Staples shall be placed on two feet (2′) centers throughout the mat. Staples shall be placed no more than eighteen inches (18″) apart in the center of the ditch and along the outside edge of the last mat installed. On all overlapping edges, fasteners shall be placed eighteen inches (18″) apart. At all ends of the matting fasteners shall be placed six inches (6″) apart.

3.4 STAPLE AND FASTENER LENGTHS

TYPES	LENGTH INCH (min.)
U Staple	12
T Staple	18 Main Leg 2 Secondary Leg
Wood Stakes	12

PART 4 MEASUREMENT AND PAYMENT

A. The matting will be measured and paid for at the Contract Unit Price for the area actually covered. If the top netting on the Type A matting degrades before the disturbed area is fully stabilized the Contractor shall replace the matting and reseed the affected area at no additional cost to the City. The payment will be full compensation for all matting furnished and placed, staples, fasteners and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

1. Type A Soil Stabilization Matting per square yard.
2. Type B Soil Stabilization Matting per square yard.

B. Where required, placing salvaged topsoil, placing furnished topsoil, seeding and mulching and overseeding will be measured and paid for separately at the Contract Unit Price for the respective item specified in the Contract Documents.

32 92 00 TURF AND GRASSES

32 92 19.01 TEMPORARY SEEDING, TEMPORARY WOOD CELLULOSE MULCHING AND TEMPORARY STRAW MULCHING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and placing fertilizer, temporary seed, mulch, wood cellulose fiber and temporary straw mulch on cuts, fills and other soil areas, which cannot be shaped and permanently vegetated for an extended period of time as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fertilizer: Refer to 32 92 23, Part 2, (Sodding).

B. Seed: Refer to 32 92 23.01, Part 2, (Turf Establishment).

C. Mulch (Straw and Hay): Refer to 31 25 00.01, Part 2, (Erosion and Sediment Control).

D. Wood Cellulose Fiber: Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics which will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form homogeneous slurry. The fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system. The slurry shall contain a green dye that provides easy visual inspection for uniformity of application. The manufacturer shall furnish certification (A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer) showing conformance to the following: See the table on the next page.

WOOD CELLULOSE FIBER REQUIREMENTS	
Particle Length, inch	Approximately 1/2
Particle Thickness, inch	Approximately 1/16
Net Dry Weight Content	Minimum as stated on bag
TAPPI* T 509, pH	4.0–8.5
Ash Content, TAPPI* Standard T 413, % max	7.0
Water Holding Capacity, % min	90

* Technical Association of Pulp and Paper Industry

E. The material shall be delivered in packages of uniform weight which shall not exceed seventy-five (75) lb net weight and shall bear the name of the manufacturer, the net weight and a supplemental statement of the net weight content.

F. Water: Refer to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

3.1 GENERAL

Temporary seeding, temporary wood cellulose mulching and temporary straw mulching shall be done any time of the year, as directed by the Engineer. Grading and shaping operations may be required before temporary seeding.

3.2 TEMPORARY SEEDING

A. Temporary seeding shall consist of preparing soil, seeding, fertilizing, mulching and applying wood cellulose fiber binder. Temporary seeding shall be done to areas that will remain undisturbed for one (1) month or more.

1. Soil Preparation. Soil shall be loosened from the grading operation. Compacted soil surfaces shall be loosened as approved by the Engineer before seed is applied.
2. Seeding, Fertilizing and Mulching. Seeding, fertilizing and mulching shall conform to 32 92 23.01, Part 3, (Turf Establishment).
3. Application Rates.

TEMPORARY SEEDING		
MATERIAL	**LB PER 1000 FT^2**	**LB PER ACRE**
Temporary Seed Mix	2.9	125
Fertilizer (15-30-15)	10.3	450
Mulch (Straw or Hay)	91.8	4000
Wood Cellulose Fiber	17.2	750

3.3 TEMPORARY WOOD CELLULOSE MULCHING

A. Temporary wood cellulose mulching shall consist of applying wood cellulose fiber to those areas that will be disturbed in less than one (1) month.

1. Soil Preparation. Soil shall be left in the condition from the grading operation.
2. Mulching. Wood cellulose fiber shall be mixed with water in a hydroseeder and applied uniformly. Temporary wood cellulose mulching shall consist of wood cellulose fiber applied at the rate of thirty-four and four-tenths to forty-five and eight-

tenths (34.4 to 45.8) lb per one thousand (1000) ft^2 or fifteen hundred to two thousand (1500 to 2000) lb per acre.

3.4 TEMPORARY STRAW MULCHING

A. Temporary straw mulching shall consist of applying temporary straw mulch by hand to small areas as determined by the Engineer that will be disturbed in less than one (1) month.

1. Soil Preparation. Soil shall be left in the condition from the grading operation.
2. Mulching. Straw mulch applied by hand shall provide a loose depth of not less than one and one-half inches (1-1/2″) nor more than three inches (3″). Ninety-five percent (95%) of the straw mulch will be six inches (6″) or more in length. Temporary straw mulching shall be applied at the rate of ninety-one and eight-tenths (91.8) lb per one thousand (1000) ft^2 or four thousand (4000) lb per acre and secured by a method approved by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the Work. Repairs due to the Contractor's negligence as determined by the Engineer shall be done at no additional expense to the City. After acceptance, mulch requiring replacement, as directed by the Engineer, will be paid for as additional Work.

B. Temporary Seeding will be measured and paid for at the Contract Unit Price per pound of seed.

C. Temporary Wood Cellulose Mulching will be measured and paid for at the Contract Unit Price per ton of wood cellulose fiber.

D. Temporary Straw Mulching will be measured and paid for at the Contract Unit Price per square yard of temporary straw mulching.

32 92 19.02 WOODY SHRUB SEEDING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of soil preparation, seeding, fertilizing, mulching, liming as required and refertilizing all areas designated for woody shrub seeding as specified in the Contract Documents, 32 92 23.01, (Turf Establishment) or as directed by the Engineer.

1.2 SEEDING SEASON

Seeding shall be done during any seeding season specified in 32 92 23.01, (Turf Establishment)..

PART 2 PRODUCTS

2.1 MATERIALS

A. Mulch Binder shall conform to 32 12 16.13, (Plant Mixed Asphalt Paving) and 31 25 00.01, Part 2, (Erosion and Sediment Control).

B. Agricultural Limestone shall conform to 32 92 23.01, Part 2, (Turf Establishment).

C. Fertilizer shall conform to 32 92 23, Part 2, (Sodding).

D. Seed shall conform to 32 92 23.01, Part 2, (Turf Establishment).

E. Mulch shall conform to 31 25 00.01, Part 2, (Erosion and Sediment Control).

F. Water shall conform to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

Refer to 32 92 23.01, Part 3, (Turf Establishment) and the following:

3.1 SEEDING

A. Seeding shall consist of soil preparation, liming, seeding, fertilizer and applying and securing mulch in conformance with 32 92 23.01, Part 3, (Turf Establishment) with the following exceptions:

1. Cover Companion Seed Mix: The Contractor shall provide the cover companion seed mix.
2. Woody Seed Mix: The City will provide the woody seed mix.
3. Application Rates:

MATERIALS	LB PER ACRE
Agricultural Limestone	Refer to 32 92 23.01, Part 3
Woody Shrub Mix	50
Cover Companion Mix	35
Lovegrass or Foxtail Millet	2 10
Rye Grain	22
Fertilizer: 5-20-20 38-0-0 (UF)	 1000 650
Refertilizing: 0-20-20 38-0-0 (UF)	 400 650
Mulch	5000
Mulch Binder Wood Cellulose Fiber	 750

3.2 NONTOPSOILED AREAS

Refer to 32 92 23.01, Part 3, (Turf Establishment).

3.3 REFERTILIZING

Refertilizing shall be performed not less than three (3) months after seeding. Refertilizing shall consist of applying 0-20-20 and 38-0-0 (UF) fertilizer to nontopsoiled and serrated cut slope areas and other areas as directed by the Engineer, as follows:

NUMBER OF APPLICATIONS	MONTHS AFTER SEEDING
1	April or September

PART 4 MEASUREMENT AND PAYMENT

A. Woody shrub seeding will be measured and paid for at the Contract Unit Price for the items below as specified in the Contract Documents. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Cover Companion Seed Mix per pound. City furnished woody shrub seed mix, the Contractor furnished companion seed, out of season seed, 5-20-20 fertilizer and mulch will not be measured but the cost will be incidental to this item.

1. Liming Nontopsoiled Areas per ton.
2. Applying 38-0-0 (UF) Fertilizer per pound.
3. Refertilizing 0-20-20 and 38-0-0 (UF) per pound for the combined weight of both fertilizers.

32 92 19.03 WILDFLOWER SEEDING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of wildflower seeding as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Water shall conform to 32 92 23.01, Part 2, (Turf Establishment).

B. Herbicide shall conform 32 92 23.01, Part 2, (Turf Establishment).

C. Marking Dye shall conform to 32 92 23.01, Part 2, (Turf Establishment).

D. Wildflower Seed Mix and Companion Seed Mix shall be furnished by the City.

PART 3 EXECUTION

3.1 SEEDING SEASONS

Seeding shall be done during October 1 to April 15.

3.2 PESTICIDE APPLICATION

A. All pesticide applications shall be as specified in the Maryland Pesticide Applicator's Law and in conformance with the manufacturer's recommendations. All pesticide applications shall be performed under the supervision of a certified applicator of pesticides (Category III A or VI).

B. Herbicide. All vegetation in the seeding area shall be eradicated prior to seeding by use of herbicide. The herbicide shall be glyphosate with a wetting agent mixed with water and a water soluble marking dye, applied at the following rates:

1. Herbicide: Five (5) lb per acre of active ingredient
2. Marking Dye: Six to fifteen (6 to 15) oz per acre
3. Water: Forty to fifty (40 to 50) gal per acre

C. Reports. The Contractor shall submit daily herbicide application reports to the Engineer using City forms.

3.3 MOWING

A minimum of two (2) weeks after herbicide treatment, the area to be seeded shall be mowed to a maximum height of one inch (1″). Clippings shall be removed prior to seeding.

3.4 SEEDING

A. Seeding shall consist of soil preparation and sowing seed.

1. Soil Preparation.

a. Soil preparation is not required when using a drill seeder.
b. Seeding area shall be rototilled to a depth of one inch (1″) prior to seeding when using a broadcast seeder.

2. Equipment. Seeding equipment shall be approved by the Engineer. Seeds shall be planted using a drill or broadcast seeder. If a drill seeder is used, it shall be equipped with three (3) seed boxes.

3. Methods.

a. Drill Seeding. Seed shall be premixed and placed in the seed boxes A, B, and C as noted in paragraph 3.5. Seed mix shall be drilled through the dead turf and thatch into the soil to a depth of one-quarter inch (1/4″).
b. Broadcast Seeding. All seed listed in paragraph 3.5 for boxes A, B, and C shall be combined and uniformly mixed with calcine clay carrier (cat litter). Seed mix shall be spread in a criss-cross pattern. After spreading

the mixture shall be lightly raked or dragged to a maximum depth of one-eighth inch (1/8″).

3.5 MIXES AND SEEDING RATES

MATERIAL	LB PER ACRE
BOX A – WILDFLOWER and COMPANION SEED	
Spurred Snapdragon	0.50
Plains Coreopsis	1.00
Corn Poppy	1.00
Black-Eyed Susan	1.00
Scarlet Sage	0.50
Lemon Mint	0.50
Shasta Daisy	0.20
New England Aster	0.20
Siberian Wallflower	0.50
Evening Primrose	0.10
White Yarrow	0.20
California Poppy	1.00
Hard or Sheep Fescue	10.00
BOX B – WILDFLOWER SEED	
Dames Rocket	1.00
Rocket Larkspur	0.50
Tall Cornflower	1.25
Purple Cornflower	2.00
Lance-Leaf Coreopsis	1.00
Yellow Cosmos	0.25
Purple Cosmos	0.25
Sweet William	0.50
Crimson Clover	1.00
BOX C – FLUFFY WILDFLOWER SEED	
Firewheel	0.20
Blanket Flower	1.00
Calendula	0.50
Sunflower Autumn Beauty	0.20

PART 4 MEASUREMENT AND PAYMENT

Wildflower Seeding will be measured and paid for at the Contract Unit Price per square yard. The payment will be full compensation for herbicide, marking dye, mowing, soil preparation and seeding (excluding the cost of wildflower and companion seed) and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

32 92 23 SODDING

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of soil preparation, liming, fertilizing, watering, and placing grass sod on prepared areas, as specified in the Contract Documents or as directed by the Engineer.

1.2 REGIONAL REQUIREMENTS

A. Tall fescue sod shall be used unless otherwise noted.

B. Bermuda grass sod shall be used when called for in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Agricultural Limestone shall conform to 32 92 23.01, Part 2, (Turf Establishment).

B. Fertilizer shall conform to the following:

1. Granular and Liquid Fertilizer: Fertilizer shall be commercial grade conforming to all State and Federal regulations and the Standards of the Association of Official Analytical Chemists. Standard analyses shall be: 0–20–20, 5–20–20, 10–10–10, 10–20–10, 10–22–22 (fifty percent (50%) nitrogen from 38–0–0 urea form), 20–20–20 and 38–0–0 (urea form). All analyses are subject to approval by the Engineer prior to application.
2. Fertilizer Packets: Fertilizer shall be contained in a slow release polyethylene perforated bag with micropore holes for controlled feeding. The bag shall contain four (4) oz of water-soluble fertilizer, analysis 16–8–16 to be effective for approximately eight (8) years.
3. Minimum guaranteed analysis of the packets shall be as follows:

MINIMUM ANALYSIS	
Total Nitrogen (N) 16%	9% Ammoniacal Nitrogen (NH_3N) 7% Nitrate Nitrogen (NO_3N)
Available Phosphoric Acid (P_2O_5)	8% from Ammonium Phosphate (NH_4PO_4)
Soluble Potash (K_2O)	16% from Potassium Chloride (KCl)
Potential Acidity equivalent to 850 lb Calcium Carbonate ($CaCO_3$) per ton.	

4. Fertilizer Tablets: Fertilizer tablets shall consist of a minimum twenty-one (21) gram tablet containing a slow release (two (2) year) fertilizer, analysis 20–10–5.
5. Minimum guaranteed analysis of the tablets shall be as follows:

MINIMUM TABLET ANALYSIS	
Total Nitrogen (N) 20%	7% Water Soluble Organic Nitrogen 13% Water Insoluble Organic Nitrogen
Available Phosphoric Acid (P_2O_5)	10%
Soluble Potash (K_2O)	5%

6. Iron Sulfate: Iron sulfate shall be an approved horticultural product produced as a fertilizer for supplying iron and as a soil acidifier.

C. Grass Sod: Sod shall either be Maryland Certified or Maryland Approved Sod and shall comply with the Maryland Turf Grass Law and Certification Regulations of the Annotated Code of Maryland. Each load of sod shall bear a Maryland State Approved or Certified label at the time of delivery on the job. The sod shall be well rooted and shall be grown in the State of Maryland. It shall be field grown for a minimum of twelve (12) months. Once cut and rolled, sod shall be placed within forty-eight (48) hours. It shall be cut in strips not less than fourteen inches (14″) or more than twenty inches (20″) wide. Sod shall be machine cut to a uniform thickness of three-quarters inch (3/4″), plus or minus one-quarter inch (± 1/4″), at the time of cutting. Thickness shall exclude top growth and thatch. Sod shall be relatively free of thatch, three-eighths inch (3/8″) or less at time of cutting. Prior to cutting, sod shall be mowed to a height of one and one-half inches to two and one-half inches (1-1/2″ to 2-1/2″) for Bluegrass, three-quarters inch to one inch (3/4″ to 1″) for Bermuda grass, and two to two and one-half inches (2″ to 2-1/2″) for tall fescue.

D. Staples shall conform to 32 91 16.16, Part 2, (Soil Stabilization Matting).

E. Water shall conform to 32 92 23.01, Part 2, (Turf Establishment).

F. Pegs shall conform to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

3.1 GENERAL

Sod shall be transported and installed without breaking, tearing or loss of soil. All sod shall be transplanted within forty-eight (48) hours from the time it is harvested.

3.2 SODDING SEASON

Sod shall be placed between the dates of August 15 and May 31. Sod shall not be placed on frozen soil and frozen sod is prohibited.

3.3 FINAL GRADING

The areas to be sodded shall present a smooth, uniform surface true to line and cross section and any raking required to accomplish this shall be done immediately prior to the placing of the sod at no additional cost to the City.

3.4 LIMING AND FERTILIZING

All areas to be sodded shall be limed and fertilized.

APPLICATION RATES	
MATERIAL	**LB PER ACRE**
Agricultural Limestone	4000
Fertilizer 10-10-10 38-0-0 (UF)	 900 200

After the above materials have been applied, they shall be worked into the top three inches (3″) of soil.

3.5 PLACING

A. Sod shall be placed with close joints and no overlapping. Cracks are prohibited between sod pieces. All sod shall be tamped or rolled after placing to close the seams between the sod pieces and to press the sod tight against the ground. A hand tamper shall weigh approximately fifteen (15) lb and have a flat surface of approximately one hundred (100) in^2. A roller shall weigh forty (40) lb/ft of width. Any slipping of sod shall be corrected by the Contractor at no additional cost to the City.

B. On slopes of two to one (2:1) and steeper, sod shall be placed with the long edges parallel to the contour starting at the bottom of the slope. Successive strips shall be neatly matched and all joints staggered or broken. When placing sod in drainage ditches, the length of the strip shall be laid parallel to the direction of the flow of the water. Each strip or section of sod placed on slopes of two to one (2:1) and steeper and surface drainage V-shaped or flat bottom ditches or gutters shall be staked securely with at least two (2) staples or wooden pegs spaced not more than two feet (2′) apart and driven flush with the top of the sod.

3.6 INITIAL WATERING

Each section of sod shall be thoroughly watered a minimum of three (3) times after placement. The first watering shall be within four (4) hours after the sod is placed and shall wet the soil to a depth of three inches (3″) below the sod. The second and third watering shall be within ten (10) days after the sod is placed. A minimum of twenty-four (24) hours shall elapse between the second and third watering.

3.7 REFERTILIZING

After the sod has been watered three (3) times and no later than three (3) weeks after placing, it shall be refertilized with 38-0-0 (UF) fertilizer at the rate of two hundred (200) lb/acre.

3.8 ACCEPTANCE

At the time of acceptance all sod shall be firmly knitted, show signs of good health and have received initial watering and refertilization.

3.9 ADDITIONAL WATERING OF SOD

The Contractor shall monitor the water needs of the sod to maintain adequate moisture in the upper four inches (4″) of soil. When additional watering is necessary, the Engineer shall be notified and if the Engineer concurs, the Contractor shall begin watering immediately.

PART 4 MEASUREMENT AND PAYMENT

A. Sodding will be measured and paid for at the Contract Unit Price per square yard. The payment will be full compensation for all sod, initial watering, staking, liming, fertilizing, refertilizing and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

B. Additional Watering of Sod: Additional Watering of Sod will be measured and paid for at the Contract Unit Price per one thousand (1000) gallons of water applied to the sod. Water will be measured by means of satisfactorily installed meters or by measurements of tank capacities or by acceptable documentation of tanks of predetermined capacity. The Contractor shall furnish the Engineer's representative with measurement and capacities to provide a complete and accurate record of the quantity of water furnished and applied. The payment will be full compensation for all water, material, labor, equipment, tools and incidentals necessary to complete the Work. No compensation will be allowed for water wasted or excess watering as determined by the Engineer.

32 92 23.01 TURF ESTABLISHMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of soil preparation, seeding, fertilizing, liming, mulching, overseeding, refertilization and mowing all areas designated for turf establishment as specified in the Contract Documents or as directed by the Engineer. Liming and fertilizing rates will be determined by the Nutrient Management Plan.

1.2 SEEDING SEASONS AND SEED MIXES

SEEDING SEASONS AND SEED MIXES		
SPRING AND FALL MONTH/DAY	SUMMER MONTH/DAY	LATE FALL MONTH/DAY
Permanent Seed Mix		
3/1 to 5/15 and 8/1 to 10/20	5/16 to 7/31	10/21 to 11/20
No Additives	Plus Additive A	Plus Additive B
Plus Additive C for seeding: a. On rippable rock. b. Areas 30 ft or greater from the edge of the payment. c. Slopes 3:1 and steeper.		
Refer to 2.1.D for seed mix contents: A = Lovegrass or Foxtail Millet B = Temporary Seed Mix C = Serecia Lespedeza		

PART 2 PRODUCTS

2.1 MATERIALS

A. Mulch Binder shall conform to 32 12 16.13, Part 2, (Plant Mix Asphalt Pavement) or the following:

1. Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics, which will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form homogeneous slurry. The fiber shall perform satisfactorily in hydraulic seeding equipment without

clogging or damaging the system. The slurry shall contain a green dye that provides easy visual inspection for uniformity of application.

2. The manufacturer shall furnish certification (A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement). The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer) showing conformance to the following:

WOOD CELLULOSE FIBER REQUIREMENTS	
Particle Length, inch	Approximately 1/2
Particle Thickness, inch	Approximately 1/16
Net Dry Weight Content	Minimum as stated on bag
TAPPI* T 509, pH	4.0–8.5
Ash Content, TAPPI* Standard T 413, % max	7.0
Water Holding Capacity, % min	90

* Technical Association of Pulp and Paper Industry.

3. The material shall be delivered in packages of uniform weight, which shall not exceed seventy-five (75) lb net weight and shall bear the name of the manufacturer, the net weight and a supplemental statement of the net weight content.

B. Agricultural Limestone shall contain not less than eighty-five percent (85%) calcium and magnesium carbonates. Dolomitic (magnesium) limestone shall contain at least ten percent (10%) magnesium as magnesium oxide and eighty-five percent (85%) calcium and magnesium carbonates. Limestone shall conform to the following gradation:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
No. 10	100
No. 20	98
No. 100	50

C. Fertilizer shall conform to 32 92 23, Part 2, (Sodding).

D. Seed shall conform to the following:

1. General. All seed, seed mixes and sod shall be free from Maryland prohibited noxious weed seeds and the following:

   Annual Bluegrass, Giant Foxtail, Bermuda grass, Horse Nettle, Bindweed, Spurred Anoda, Cocklebur, Wild Garlic, Corn Cockle, Wild Onion and Dodder.

2. Seed Mixes. The Contractor or seed supplier shall notify the Turf and Seed Section, Maryland Department of Agriculture, Annapolis, Maryland, at least ten (10) days prior to the mixing date as to the hour, date and location of the mixing operation. The Contractor or seed supplier shall assume charges for seed inspections and seed testing service. Seed mixes shall conform to the following:

   a. Seed Mix No. 1
      85% Tall Fescue (Certified Seed Only)
      10% Kentucky Bluegrass (Certified Seed Only)
      5% Perennial Rye grass (Certified Seed Only)

b. Seed Mix No. 2
   60% Kentucky Bluegrass (Certified Seed Only)
   40% Fine (Chewings, Creeping Red, Hard, Sheep) Fescue (Certified Seed Only)

c. Temporary Seed Mix
   95% Barley or Rye
   5% Foxtail Millet

d. Cover Companion Seed Mix
   30% Chewings Fescue
   30% Canada Bluegrass
   10% Redtop
   30% Serecia Lespedeza (inoculant required)

e. Woody Shrub Seed Mix
   25% Amur Honeysuckle (Lonicera maackii) or Tatarian Honeysuckle (Lonicera tatarica)
   20% Bristly Locust (Robina fertilis) (inoculant required)
   25% Shrub Lespedeza (Lespedeza bicolor) (inoculant required)
   30% Arrowwood Viburnum (Viburnum dentatum)

f. The woody shrub seed mix shall have a minimum purity of 98 percent.

g. Wildflower Seed Mix
   3% Spurred Snapdragon (Linaria maroccana)
   6% Plains Coreopsis (Coreopsis tinctoria)
   6% Corn Poppy (Papaver rhoeas)
   6% Black-Eyed Susan (Rudbeckia hirta)
   3% Scarlet Sage (Salvia coccinea)
   3% Lemon Mint (Monarda citriodora)
   1.2% Shasta Daisy (Chrysanthemum maximum)
   1.2% New England Aster (Aster novae angliae)
   3% Siberian Wallflower (Cheiranthus allioni)
   0.6% Evening Primrose (Oenothera hookerii)
   1.2% White Yarrow (Achillea millefolium)
   6% California Poppy (Eschschoizia California)
   7% Dames Rocket (Hesperis matronalis)
   3% Rocket Larkspur (Delphinium ajacis)
   7.6% Tall Cornflower (Centaurea cyanus)
   12.2% Purple Cornflower (Echinacea purpurea)
   6% Lance-leaf Coreopsis (Coreopsis lanceolata)
   1.5% Yellow cosmos (Cosmos sulphureus)
   1.5% Purple Cosmos (Cosmos bipinnatus)
   3% Sweet William (Dianthus barbatus)
   6.6% Crimson Clover (Trifolium incarnatum)
   1.2% Firewheel (Gaillardia aristata)
   6% Blanket Flower (Gaillardia pulchella)
   3% Calendula (Calendula officianialis)
   1.2% Sunflower Autumn Beauty (Helianthus Autumn Beauty)

h. The wildflower seed mix shall conform to the following:

75% Minimum Germination
98% Minimum Purity

i. Cover Companion Seed for Use with Wildflower Seed Mix: 100% Hard Fescue (Festuca longifolia) or Sheep Fescue (Festuca ovina)

3. Seed. Seed will be sampled and tested by an inspector from the Turf and Seed Section, Maryland Department of Agriculture (MDA), Annapolis, Maryland. All seed containers shall be tagged with a MDA supervised mix program seed tag. Seed shall comply with the Maryland Seed Law, Agricultural Article of the Annotated Code of Maryland. The authority for seed names shall be the current printing of USDA, Agriculture Handbook.

4. Grass and legume seeds shall conform to the latest Construction directives regarding cultivars and varieties and the following:

SEED	PURITY NOT LESS THAN %	WEED SEED NOT MORE THAN %	MINIMUM GERMINATION (including hard seed) %	HARD SEED NOT TO EXCEED %
Kentucky Bluegrass: (Poa pratensis)	90	0.4	80	—
Canada Bluegrass: (Poa compressa)	90	0.5	80	—
Redtop: (Agrostis gigantea)	92	0.7	80	—
Lehmann's Lovegrass: (Eragrostis lehmanniana)	98	0.5	80	—
Foxtail Millet: (Setaria italica)	99	0.1	80	—
Hard and Fine Fescue: (Festuca longifolia)	98	0.5	85	—
Sheep Fescue: (Festuca ovina)	98	0.5	85	—
Tall Fescue: (Festuca arundinacea)	98	0.5	90	—
Chewings Fescue: (Festuca rubra commutata)	98	0.5	85	—
Oats: (Avena sativa)	99	0.5	90	—
Crownvetch: (Coronilla varia)	98	0.5	80	30
Serecia Lespedeza: (Lespedeza cuneata)	98	0.5	85	20
Birdsfoot Trefoil: (Lotus corniculatus)	97	0.7	85	20
Weeping Lovegrass: (Eragrostis curvula)	98	0.5	80	—
Barley: (Hordeum vulgare)	98	0.3	90	—
Rye Grain: (Secale cereale)	98	0.1	85	—
Perennial Ryegrass: (Lolium perennial)	98	0.5	85	—

E. Mulch shall conform to 31 25 00.01, Part 2, (Erosion and Sediment Control).

F. Miscellaneous shall conform to the following:

1. Water: Water used in the planting, establishing or caring for vegetation shall be free from any substance that is injurious to plant life.

2. Peat Moss: Peat moss shall be milled sphagnum peat moss and shall be free from woody subtances.
3. Peat Humus: Peat humus shall originate from fresh water sites of sedge and reed peat deposits in which the organic matter consists of incompletely decomposed plant residues containing a minimum of seventy percent (70%) organic material by weight and a negligible amount of woody matter by visual inspection. Inorganic material shall consist only of sand, silt and clay without inclusion of gravel, debris or toxic compounds. Peat humus with a pH value of less than four point five (4.5) shall be corrected to a value of six point five (6.5) by the addition of limestone as directed by the Engineer. Samples of peat humus will be taken by the Engineer and will be tested for conformance to federal Specifications.
4. Manure: Manure shall be dehydrated cow manure as approved by the Engineer.
5. Compost: Compost shall be screened, approved by the state agencies, and subject to approval by the Engineer. Compost shall have a pH between six and seven point five (6.0 and 7.5) except when specified in 32 90 00.01 (Planting Trees, Shrubs, Vines and Seeds), where it shall have a pH between six and seven (6.0 and 7.0). It shall be stable and not reheat upon restacking. Compost shall have moisture content between thirty percent and fifty-five percent (30% and 55%), a particle size of five-tenths inch (0.5) or less.

    a. Grading analysis shall be as follows:

SIEVE SIZE (mm)	MAXIMUM PERCENT PASSING BY VOLUME
4.75	90
.425	25
0.75	2.2

    b. Compost shall be one of the following types:

        1) Biosolids: Compost (Type A). Biosolids compost will be approved for distribution by the Maryland Department of the Environment. Compost shall a soluble salt concentration not to exceed ten (10) dS (mmhos/cm).
        2) Source-Separated Compost (Type B). Source separated compost will be approved by the Maryland Department of Agriculture (MDA). Compost shall be produced by a MDA certified compost operator. Compost shall have a soluble salt concentration not to exceed five (5) dS (mmhos/cm).
        3) Source separated compost shall be one of the following types:
            a) Tree leaf compost.
            b) Non-tree leaf compost: When compost is from lawn clippings, it shall be tested for contaminants in conformance with COMAR 15.18.04.05.

6. Insecticide: Insecticide shall be an EPA approved chemical that provides protection against insect pests. The insecticide will be subject to approval by the Engineer.
7. Herbicide: Herbicide shall be an EPA approved chemical to control and prevent re-growth of undesirable vegetation. The herbicide will be subject to approval by the Engineer.

8. Marking Dye: Marking dye shall be herbicide compatible and oil or water soluble, as required. Marking dye shall be from a commercial source as approved by the Engineer.
9. Stakes: Stakes for supporting trees shall be rough sawn, straight grain hardwood reasonably free from knot holes, bark, wane, warp and splits, as determined by the Engineer. Stakes shall be full cut two inches by two inches (2″ X 2″) thickness. The length shall be as specified in the Contract Documents.
10. Outline Stakes: Outline stakes shall be full cut one and three-quarter inches by one and three-quarter inches (1-3/4″ X 1-3/4″) sound hardwood, forty-eight inches (48″) long, as approved by the Engineer. They shall have the words “MOW LIMIT” stenciled in orange paint vertically on one side in one and one half-inch (1-1/2″) letters beginning within two inches (2″) from the top of the stake.
11. Wire: Wire shall be No. 12 gauge and 14 gauge new annealed galvanized wire, as approved by the Engineer.
12. Wire Rope: Wire rope shall be one-quarter inch (1/4″) zinc coated steel wire seven (7) strands as commonly used for guying large trees and as approved by the Engineer.
13. Cable Clamps: Cable clamps shall be galvanized or cadmium plated as approved by the Engineer.
14. Hose: Hose shall be five-eighths inch (5/8″) inside diameter corded synthetic rubber hose or as approved by the Engineer.
15. Turnbuckles: Turnbuckles shall be galvanized or cadmium plated with four and one-half inch (4-1/2″) openings and five-sixteenths inch (5/16″) threaded ends with screw eyes.
16. Anchors: Tree anchors shall be earth anchors of a type commonly used for anchoring large trees and as approved by the Engineer.
17. Wrapping Material: Wrapping material for trees shall be clean new burlap six to seven (6 to 7) oz/yd^2 in strips four inches to six inches (4″ to 6″) wide.
18. Twine: Twine used for tying wrapping on trees shall be three (3) ply untreated jute twine as approved by the Engineer.
19. Antidesiccant: Antidesiccant shall be an approved emulsion, which will provide a film over plant surfaces permeable enough to permit transpiration.
20. Tree Wound Dressing: Tree wound dressing shall be an asphalt-based emulsion prepared especially for tree pruning operations.
21. Pegs: Pegs shall be wooden wedges one-half inch by one inch by six inches (1/2″ X 1″ X 6″) to one-half inch by one inch by twelve inches (1/2″ X 1″ X 12″) as approved by the Engineer.
22. Water: Absorbent Gel: Water absorbent gel shall be a cross-linked polyacrylamide horticultural product used to maintain moisture around bare root plants and as a soil conditioner. Formulas used shall conform to the manufacturer''s recommendations.

G. Soil Sampling: This procedure is used to sample and test the soil for pH, organic matter, grading analysis, textural analysis, phosphorus and potassium. The procedure is also used to develop a Nutrient Management Plan (NMP) for permanent seeding and sodding.

1. Equipment: Soil samples shall be gathered with the following equipment:

   a. Shovel, spade or a soil probe.
   b. Soil sample bags with liners capable of containing twenty (20) lb.
   c. Pint jars with airtight lids.

d. Labels and tags.
e. Scale and sieves.
f. Refer to T 88.

Sampling Procedures: A twenty (20) lb soil sample shall be collected from a minimum of ten (10) locations to represent all the soil to be tested. The soil shall be tagged, labeled, and sent to the soils laboratory for testing.

2. Preliminary Engineering Projects: For preliminary engineering projects, the soil surveyor will determine the source areas of salvaged topsoil.
3. Active Construction Projects: For active Construction projects, the Contractor will contact the soils laboratory at least thirty (30) Calendar Days prior to any of the following:

a. The stripping of the salvaged topsoil.
b. Placing of the topsoil.
c. The seeding of nontopsoiled areas.

5. Salvaged Topsoil: Topsoil shall be sampled prior to stripping or from each stockpile on the project.
6. Furnished Topsoil: Topsoil sample shall be taken from the supplier's captured stockpile.
7. Nontopsoiled Areas: Soil shall be sampled from the cut slope, nontopsoil stockpile, or combination thereof.
8. Testing Procedures: Each twenty (20) lb sample shall be mixed and a representative sample placed in a pint jar. The jar sample shall be tested for phosphorus and potassium by a state university. The jar shall be labeled with the following information:

a. Contract Number.
b. Contractor's name, phone and fax numbers.
c. The type of soil — Salvaged topsoil, Furnished topsoil or Nontopsoiled areas.
d. Furnished topsoil shall have the name of the source.
e. Nontopsoiled areas shall have the location of the site.

9. The remaining portion of the soil sample shall be dried and graded for sieve sizes along with silt, sand, clay content, pH and tested for organic matter by the soils Laboratory.

H. Test Results: After completing the soil testing, all test results shall be forwarded to the Contractor for the development of a Nutrient Management Plan (NMP) for the project. The Contractor will forward the NMP to the Engineer, with a copy to the soils Laboratory and other appropriate personnel.

1. Minimum Testing Quantities: The following rules pertain to the testing of the minimum quantities of topsoil, including salvaged, furnished and nontopsoiled areas:

a. Regardless of quantity, all topsoil will be tested that is placed in front of or at residential, commercial and City facilities where permanent seeding/sodding is to be performed.
b. A minimum of thirty (30) yd^3 of topsoil being placed in all other areas.
c. A minimum of five thousand (5000) ft^2 of nontopsoiled areas.

PART 3 EXECUTION

3.1 GENERAL

Seeding shall be performed when the temperature is above thirty-two degrees (32°) F and the ground is not frozen.

3.2 Permanent Seeding Areas with less than four inches (4″) of Topsoil. Seeding shall consist of soil preparation, liming, seeding, fertilizing and applying and securing mulch.

A. Preparing Soil: Areas to be seeded shall conform to the specified finish grades and be free of any weed or plant growth. All areas (except serrated cut slopes) shall be loosened by discing, harrowing, raking or by other approved methods immediately prior to seeding, unless otherwise directed by the Engineer. The area shall be free of all clods, stones and other foreign materials larger than three inches (3″). On and adjacent to commercial and residential properties, the size of stones and other foreign material shall not be larger than one and one-half inches (1-1/2″). All gullies, washes or disturbed areas that develop subsequent to final dressing shall be repaired prior to seeding. On slopes less than three to one (3:1) and on flat areas, the final seedbed shall be prepared so there is an even and uniform germination of seed and final stand of turf. To conserve moisture, a cultipacker may be run over the seedbed before or after seeding, but before mulching. The seed beds shall be as follows:

1. Slopes Less than three to one (3:1): The topsoil shall be loosened to a depth of two inches (2″) and all track marks shall be removed.
2. Slopes three to one (3:1) and Steeper: The subsoil shall be loosened to a depth of one inch (1″).
3. Serrated Cut Slopes: The subsoil shall not be loosened. The areas shall be seeded and mulched in fifty feet (50') maximum vertical increments.

B. Application Equipment: Equipment shall consist of spreaders, drills, hydroseeders or other equipment approved by the Engineer for applying materials either in a wet or dry form. All equipment shall be calibrated before application to the satisfaction of the Engineer so that materials are applied accurately and evenly to avoid misses and overlaps.

1. Hydroseeders shall display maximum capacity in gallons and be equipped with an agitation system capable of keeping all the solids in a state of suspension.
2. The mixture shall be directed upward into the air so droplets will fall in a uniform spray to avoid erosion or runoff.
3. Mechanical seeders shall be capable of placing seed at the specified rate.
4. Use of hydroseeders and spinner spreaders is prohibited during periods of high winds when the materials could land on sensitive areas or on sensitive structures.

C. Application Rates:

MATERIAL	LB PER ACRE
AGRICULTURE LIMESTONE Salvaged Topsoil Areas, Furnished Topsoil Areas, Nontopsoiled Areas and Serrated Cut Slopes Limestone	 Specified in Nutrient Management Plan Up to 8700
SEED Permanent Seed Mix Areas that are: (a) Less than 30 feet from the pavement edge that are flat and have slopes flatter than 3:1 (b) At facilities	150
SEED Permanent Seed Mix Serecia Lespedeza Areas that are: (a) 30 ft or greater from the edge of the pavement (b) Slopes 3:1 and steeper (c) Rippable rock	 100 20
SEED Temporary Seed Mix Lovegrass Foxtail Millet	 25 2 10
FERTILIZER AT SEEDING Topsoiled Areas 10-22-22 (50% urea form nitrogen) 38-0-0 (urea form) 0-0-60 Nontopsoiled Areas 10-22-22 (50% urea form nitrogen) 38-0-0 (urea form) 0-0-60	Specified in Nutrient Management Plan Up to 1000 Up to 130 Up to 180 Up to 1000 Up to 250 Up to 200
REFERTILIZING Topsoiled Areas 5-20-20 38-0-0 (urea form) Nontopsoiled Areas 5-20-20 38-0-0 (urea form)	 100 400 400 600
MULCH (a) Straw or Hay (1) Secured with Wood Cellulose Fiber (2) Secured with Mulch Anchoring Tool (3) Secured with the Tracking Method (b) Wood Cellulose Fiber	 4000 5000 3000 1500
MULCH BINDER Wood Cellulose Fiber	 750

D. Liming: Agricultural limestone where required on topsoiled areas flatter than three to one (3:1), shall be incorporated two inches (2″) into the topsoil before seed and fertilizer are applied. Agricultural limestone where required on all areas three to one (3:1) and steeper, may be mixed with the seed and fertilizer.

E. Seeding and Fertilizing: Seed and fertilizer shall only be applied to previously prepared seedbeds.

1. When seed is applied with hydraulic seeders, all mixtures shall be used within eight (8) hours after mixing.
2. When seed is sown with mechanical seeders, seed and fertilizer shall be incorporated to a depth not more than one-quarter inch (1/4″).
3. All leguminous seeds shall be inoculated as specified on the inoculant package label. The inoculant shall be stored at room temperatures, out of direct sunlight and away from heating units.
4. When leguminous seed is sown by hydraulic seeders, ten (10) times the quantity of inoculant required for dry leguminous seed application shall be used. Seed not used within one (1) hour shall be reinoculated.
5. When leguminous seed is sown by mechanical seeders, the seed shall be dampened with water and mixed with the inoculant. The inoculated seed shall then be mixed with the other seed to be used. Inoculated seed not used within twenty-four (24) hours shall be reinoculated.

F. Mulching: Within forty-eight (48) hours after seeding, mulch shall be applied as follows:

1. Straw or Hay Mulch: Material shall be applied so no more than ten percent (10%) of the soil surface is exposed. Mulch applied by blowers shall provide a loose depth of one-half inch to two inches (1/2″ to 2″). At least ninety five percent (95%) of the mulch shall be six inches (6″) or more in length. Mulch applied by hand shall provide a loose depth of one and one-half inches to three inches (1-1/2″ to 3″).
2. Wood Cellulose Fiber Mulch: Wood cellulose fiber will only be permitted on those areas where steep or high slopes prohibit the use of straw or hay application equipment or when approved by the Engineer. During summer seeding at least seventy percent (70%) of the hydromulch shall be applied after and separately from the seed and fertilizer.

G. Securing Straw or Hay Mulch: Mulch shall be secured by any of the following methods:

1. Mulch Anchoring Tool Method: This method shall be used for the summer seeding season on slopes three to one (3:1) and flatter and all median areas on highways under traffic. Mulch shall be incorporated into the soil to a minimum depth of two inches (2″).
2. Tracking Method: The mulch shall be incorporated into the soil with track type equipment having steel cleats with a minimum depth of one and one-half inch (1-1/2″). The tracking shall be performed perpendicular to the slopes. The equipment used and the method of tracking shall be acceptable to the Engineer. Upon completion of tracking, the mulch shall be further secured as described for the mulch binding method in paragraph 3.2, 3.
3. Mulch Binding Method: Mulch binder material shall be uniformly applied without displacing the mulch.

3.3 PERMANENT SEEDING AREAS

Permanent seeding areas with four inches (4″) or more of topsoil in areas flatter than three to one (3:1), seeding shall consist of soil preparation, liming, seeding, fertilizing and applying and securing mulch in conformance with paragraph 3.2 with the following exceptions:

1. The soil shall be loosened to a depth of three inches (3″).
2. Agricultural limestone, if required, shall be applied separately and incorporated three inches (3″) into the seedbed.

3.4 NONTOPSOILED AREAS

All nontopsoiled areas to be seeded shall have limestone and 38–0–0 (UF) fertilizer applied.

3.5 OVERSEEDING

Overseeding permanent seeding areas consists of applying seed and fertilizer to previously seeded and mulched areas where turf establishment has not been successful and where remulching is not required due to mulch remaining from the previous mulch application. Work shall be as directed by the Engineer and conform to paragraphs 3.2, A and 3.2, B. Soil preparation and mulch will not be required.

3.6 REFERTILIZING

Refertilizing shall consist of applying 5-20-20 and 38-0-0 (UF) fertilizer to topsoiled, nontopsoiled and serrated cut slope areas and other areas as directed by the Engineer as follows:

AREAS	NUMBER OF APPLICATIONS	MONTHS / WEEKS AFTER SEEDING
Topsoiled	1	4 to 6 weeks
Nontopsoiled and serrated cut slopes	1	April or September

3.7 TRACTOR MOWING

Mowing shall consist of using a minimum five feet (5′) flail or rotary tractor mower as directed by the Engineer. The vegetation shall be cut to five inches (5″) high before it reaches twenty inches (20″) high.

3.8 HAND MOWING

Mowing shall consist of using a minimum nineteen inch (19″) hand mower as directed by the Engineer. Vegetation shall be cut to three inches to four inches (3″ to 4″) high before it reaches fifteen inches (15″) high.

3.9 REPAIRING DAMAGED AREAS

Before final acceptance the Contractor shall repair or replace any seeding or mulching that is defective or damaged due to the Contractor's negligence at no additional cost to the City. When the Contractor elects to perform out of season Work, the Contractor shall

establish a good stand of grass of uniform color and density as approved by the Engineer. When it is not possible to make an adequate determination of the color, density and uniformity of the stand of grass, acceptance of the areas will be delayed until seeding requirements are in conformance.

PART 4 MEASUREMENT AND PAYMENT

A. Turf Establishment will be measured and paid for at the Contract Unit Price for the items as specified in the Contract Documents. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Permanent Seeding Areas per square yard. This item includes preparing soil and seedbed, applying seed (mixes and additives), fertilizers outlined in the Nutrient Management Plan and mulch.

C. Liming Salvaged Topsoil and Nontopsoiled Areas per ton.

D. Fertilizing Nontopsoiled Areas with 38-0-0 (urea form) fertilizer per pound.

E. Overseeding Permanent Seeding Areas per pound of seed.

F. Refertilizing Topsoiled Areas per pound for the combined weight per pound of 5-20-20 and 38-0-0 (urea form) fertilizers.

G. Refertilizing Nontopsoiled Areas per pound for the combined weight per pound of 5-20-20 and 38-0-0 (urea form) fertilizers.

H. Mowing per hour. This item includes tractor and hand mowing.

I. Except when the defect or damage is due to the Contractor's negligence, once the Contractor has completed the seeding and mulching of any area as determined by the Engineer, no additional Work at the Contractor's expense will be required. Subsequent repairs and replacements as required by the Engineer shall be made by the Contractor and will be paid for as additional Work.

32 93 00 PLANTS

32 93 23 PLANTS AND BULBS (PLANTING ANNUALS, PERENNIALS, FALL PLANTED BULBS AND ORNAMENTAL GRASSES)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and planting annuals, perennials, fall planted bulbs, ornamental grasses and all plant establishment operations to complete the Work as specified in the Contract Documents or as directed by the Engineer.

1.2 PLANTING SCHEDULE

PLANTS	PLANTING DATES
Container Grown Summer Annuals	May 10–June 1
Container Grown Winter Annuals	September 15–October 15
Container Field Grown Perennials and Ornamental Grasses	April 15–June 30 or September 1–October 30
Fall Planted Bulbs	October 1–November 30

1.3 PESTICIDE APPLICATION

Refer to 32 90 00.01, (Planting Trees, Shrubs, and Vines).

PART 2 PRODUCTS

2.1 MATERIALS

A. Agricultural Limestone shall conform to 32 92 23.01, Part 2, (Turf Establishment).

B. Fertilizer shall conform to 32 92 23, Part 2, (Sodding).

C. Shredded Hardwood Bark shall conform to 31 25 00.01, Part 2, (Erosion and Sediment Control).

D. Miscellaneous shall conform to 32 92 23.01, Part 2, (Turf Establishment).

PART 3 EXECUTION

3.1 STORAGE AND HANDLING

The Contractor shall provide adequate facilities for the protection, watering and temporary storage of all plant material.

3.2 PREPARATION FOR PLANTING

A. Layout. The Contractor shall lay out the location of all beds in the field prior to performing any planting operations as approved by the Engineer.

B. Planting Bed Preparation. Two (2) weeks prior to planting, all weeds and grass located within planting bed areas shall be eradicated using glyphosate with a wetting agent in conformance with the Maryland Pesticide Applicator's Law and the manufacturer's recommendations. After the weeds have died, the planting bed areas shall be mowed to a height of one inch (1″) and the debris shall be removed prior to tilling as directed by the Engineer. Prior to rototilling, the following soil amendments shall be evenly spread over the planting bed:

   a. Two inches (2″) composted biosolids or other approved composted materials.
   b. Fifteen (15) lb/one thousand (1000) ft^2 of 5-10-10 fertilizer.
   c. The required amount of dolomitic agricultural limestone or other pH modifiers as determined by the soil tests reports. After spreading the soil amendments, the planting bed shall be rototilled to provide a depth of six inches (6″) of loose soil with a rototiller approved by the Engineer. Working soil in a wet or frozen condition is prohibited. After tilling, the planting bed shall be raked to provide an even planting surface and to remove debris and stones larger than one inch (1″). All debris shall be removed from the site and disposed of by the Contractor.

3.3 PLANTING

1. Plants shall not be installed until inspected as specified in 32 90 00.01, Part 2, (Planting Trees, Shrubs, Vines, and Seeding Stock). When planting in existing beds, the mulch and existing plants shall not be disturbed.
2. Annuals and Perennials: Prior to planting, plants shall be removed from pots without damaging plants. Annuals and perennials shall be planted through premulched cultivated beds with the mulch carefully pulled back and replaced to avoid mixing soil and mulch. When planted, the top of the root mass shall be at ground level and the plant shall be in a vertical position.
3. Fall Planted Bulbs: Prior to planting, all annuals shall be removed. Fall planted bulbs shall be planted at the depth recommended by the supplier for each specified variety of bulb. Bulbs shall be carefully handled to avoid bruising.
4. Initial Watering: Plants shall be watered immediately after planting and as required until the plants roots have knitted into the planting bed soil. The waterings shall provide full and thorough saturation of the soil in the planting bed. A sprinkler or breaker nozzle shall be used to prevent damage to the plants and disturbance of mulch during the watering operation.
5. Fertilizing: After the initial watering, a water-soluble 20-20-20 fertilizer shall be applied to each plant as specified in the manufacturer's recommendations.
6. Mulching:

    a. Annuals and Perennials. Prior to planting, a one and one-half inch (1-1/2″) layer of shredded hardwood bark mulch shall be spread over the prepared planting bed. After planting, an additional one-half inch (1/2″) shall be evenly spread over the bed.
    b. Fall Planted Bulbs. After planting, a two inch (2″) layer of shredded hardwood bark mulch shall be spread over the planting bed.
    c. Edging. Upon completion of planting, mulch beds shall be neatly edged to a depth of three inches (3″) with a vertical cut, tapered back to the area to be mulched.

7. Refertilization: Refertilization shall conform to 32 90 00.01, Part 3, (Trees, Shrubs, Vines, and Seedling Stock).

3.4 PLANT CARE DURING CONSTRUCTION

Plant care shall begin immediately after each plant is installed and shall continue through the landscape Construction phase and as specified in paragraph 3.5.

3.5 PLANT ESTABLISHMENT

A. Plant establishment shall conform to 32 90 00.01, Part 3.6, (Trees, Shrubs, Vines, and Seedling Stock) modified as follows:

1. After the initial watering has been completed, plants shall be watered as required at the rate of sixty (60) gal/one hundred (100) ft^2 of planting bed. This amount of watering is equivalent to one inch (1″) of rainfall.
2. During the normal growing season, annuals that die shall be replaced immediately when directed by the Engineer.
3. Annuals shall be removed after they have declined in the late summer or fall. The dead leaves and flower stems of most perennials shall be removed in the fall. The

leaves and flower stems of fall planted bulbs shall be removed in the summer after they have died back. All removal and maintenance of plants shall be as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Installation of annuals, perennials, fall planted bulbs and ornamental grasses will be measured and paid for at the Contract Unit Price per each item as specified in the Contract Documents. The payment will be full compensation for all plants, bulbs, initial watering, fertilizing, replacements, seasonal maintenance and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. If at any time during the Contract period any plants become unacceptable, they shall be replaced at no additional cost to the City.

B. Mulching. Shredded hardwood bark mulch within the planting beds will be measured and paid for at the Contract Unit Price per square yard. The measurement will be computed on the surface area of the specified thickness before settling or as directed by the Engineer. The payment will be full compensation for all mulch, material, labor, equipment, tools and incidentals necessary to complete the Work.

C. Additional Watering of Plants. Additional watering of plants will be measured and paid for at the Contract Unit Price per one thousand (1000) gallons of water applied to the planting beds. Water will be measured as specified in 32 92 23, Part 4, (Sodding).

D. Plant Refertilization. Plant refertilization will be measured and paid for at the Contract Unit Price per one thousand (1000) gallons of liquid fertilizer mixture applied to the plant beds in conformance with paragraph 4.C. The payment will be full compensation for furnishing fertilizer, water and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

32 93 43 TREE ROOT AERATION

PART 1 GENERAL

1.1 DESCRIPTION

This item shall consist of furnishing and placing the necessary aggregate and pipe for the protection and aeration of the roots of trees, shrubs and other woody plants specifically designated for such treatment in conformity with the requirements of the Plans and Specifications. Please refer to the latest editions of T.P. Pirone's Tree Maintenance and Richards W. Harris's Arborculture: Integrated Management of Landscaped Trees, Shrubs and Vines.

PART 2 PRODUCTS

2.1 MATERIALS

A. No. 6 Aggregate, refer to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Mulch, refer to 31 25 00.01, Part 2, (Erosion and Sediment Control).

C. Pipe shall be plain or perforated as specified in the Contract Documents in conformance with 33 41 00, Part 2, (Storm Utility Drainage Piping).

PART 3 EXECUTION

A. The feeding root area to be protected and aerated shall be the ground surface lying under and within the periphery of the branches of the tree, shrub or other woody plant which has been designated for protection. Such areas shall first be thoroughly cleaned of all vegetation, wood, brush or other debris.

B. Pipe, when required, shall be installed as nearly as possible on the surface of the ground in a pattern as shown on the Plans and to a uniform grade so as to drain properly and not trap water in the system. Perforated pipe shall be used in the aerated area and the plan pipe shall be used in constructing the outlet from the periphery of the area to the point of discharge. All pipe laying shall progress upgrade and pipe shall be laid with the bells facing upgrade. Upgrade dead ends of pipe shall be closed with stoppers of the same material as the pipe. All joints in plain or perforated pipe shall be made as described in 33 41 00, Part 2, (Storm Utility Drainage Piping).

C. Where tree wells are not required and where the earth fill is to be less than twelve inches (12″) but more than four inches (4″) deep over the feeding root area, unless otherwise specified, an aggregate aeration course of thickness equal to half the total depth of fill shall first be spread loosely over such area, except that at the tree trunk the thickness shall be increased to equal the full height of the fill and the aggregate shall extend outward from the tree trunk at this thickness in collar form, for a distance of fifteen inches (15″), unless otherwise specified.

D. Where tree wells are required, an aggregate aeration course as described above shall be placed in connection with them and prior to any other filling but no aggregate shall be placed inside the tree well (between the wall and the tree trunk (and the thickness of the aeration course shall not exceed six inches (6″) regardless of the depth of the fill.

E. After the aggregate has been placed but before any fill is placed, all areas of aggregate to be filled over shall first be covered with two inch (2″) layer of dry mulch material. The remainder of the fill shall then be placed in accordance with the provisions of 31 24 13.10, (Embankment and Subgrade), except that previous soil shall be used to fill over the aggregate.

PART 4 MEASUREMENT AND PAYMENT

A. Aggregate for this item will be measured on the basis of the volume of material acceptably placed and no deductions will be made for the volume of any pipe installed in it. "Aggregate for Tree Root Aeration" will be paid for on the basis of the Contract Unit Price per cubic yard for the volume of such material acceptably installed and such price and payment shall be full compensation for all labor, material, equipment and incidentals necessary to complete the item as specified, except pipe, but including the mulch covering which will not be measured or otherwise paid for.

B. Plain or perforated pipe will each be measured on the basis of the length of straight section is acceptably installed and special fittings will be measured on the basis of the number of each type acceptably installed. Pipe shall be paid for at the Contract Unit Price per linear foot for straight clay pipe, plan or perforated and at the Contract Unit Price per

each for special fitting which price and payment will be full compensation for all labor, materials, equipment and incidentals necessary to satisfactorily complete the Work, including the necessary plugs and stoppers and the sealing of the joints.

32 94 00 PLANTING ACCESSORIES

32 94 43 TREE GRATES

PART 1 GENERAL

1.1 DESCRIPTION

This item shall consist of the furnishing, placing and painting of tree grates at tree pits in accordance with the details and at the locations shown on the Plans.

PART 2 PRODUCTS

2.1 MATERIALS

A. Tree Grates shall be cast iron, Model R-8640, one-hundred eighty degrees (180°) Square, forty-eight inches (48″) square in size, as manufactured by the "Neenah Foundry Company, 500 Winnecone Avenue, Box 729, Neenah, Wisconsin 54956" or approved equal.

B. Bare Metal primer paint shall be "X-60 Black Bare Metal Primer" as manufactured by "Rust-Oleum Corporation, Evanston, Illinois" and distributed locally by "Budeke's Paints, 418 South Broadway, Baltimore, Maryland 21231," or approved equal.

C. Intermediate primer paint shall be "960 Zinc Chromate Primer" as manufactured by "Rust-Oleum Corporation" or approved equal.

D. Finish paints for the galvanized steel angles and tree grates, shall be "412 Flat Black", as manufactured by "Rust Oleum Corporation, Evanston, Illinois" or approved equal.

E. Paint, which has been packaged over six (6) months, shall not be used, except such paint which is known to have long package stability when unopened and then only when guaranteed by the manufacturer and approved by the Engineer.

F. Paint shall be free from skins, lumps and foreign matter, when used.

G. Only such oils, thinners and driers that have been approved for use by the paint manufacturer shall be used.

H. The paint to be used shall be taken from original containers with unbroken seals and with labels intact.

I. Samples, which shall be the standards to which the Work must conform, shall be submitted to the Engineer for approval. Any additional costs of paint required to bring the Work to the quality and colors of the approve samples, shall be provided under this Contract. The approved samples shall be maintained where directed by the Engineer, until completion and final acceptance of the entire project.

PART 3 EXECUTION

A. The manufacturer's directions shall be strictly followed and altering or thinning the paint counter to these directions, shall not be done. Where reduction is specifically required by

manufacturer's direction, it shall be done strictly as specified. Thinner and solvent used for cleaning brushes or the other clean up shall not be used in the paint.

B. The surfaces to be painted shall be cleaned of all grease, mil scale by sandblasting in accordance with Steel Structures Painting Council Specifications SP-6 Commercial Blast Cleaning prior to shop painting. They shall be shop painted with one (1) coat, fifteen-thousandths inch (0.0015″) thick of the bare metal primer paint specified in paragraph 2 materials, above. Application shall be at the rate of four hundred (400) square feet per gallon.

C. The surfaces shall be painted in the field, with one (1) coat, fifteen-thousandths inch (0.0015″) thick of the intermediate primer paint specified in paragraph 2 materials, above. Prior to the application of this intermediate primer paint, all surfaces to receive it shall be inspected for bare metal, damaged shop paint and rust. All areas shall be cleaned of rust, repaired and touched up with bare metal primer. When touch-up is dry, the intermediate primer shall be applied at the rate of four hundred (400) square feet per gallon.

D. The surfaces shall be finished with two (2) coats, fifteen-thousandths inch (0.0015″) thick per coat, of the finish paint specified in paragraph 2 materials, above, applied at the rate of four hundred (400) square feet per gallon. They shall be applied under adequate illumination, evenly and smoothly spread without runs, sags, skips, crawling or clogging. The first finish coat shall be dry and in proper condition prior to applying the second coat.

E. Finishes defective in workmanship and/or not conforming to approved color samples, shall be prepared and repainted as described above. The Contractor shall repair defective Work of any nature, until such time as the entire project is accepted.

F. All paint shall be applied in strict accordance with the manufacturer's printed instructions, which hereby become part of these Specifications.

G. Only skilled mechanics shall be employed to assure Work of the best quality. The final product shall be in accordance with the intent of the Specifications and Drawings.

H. During painting operations on the site, adjacent areas shall be protected from damage, which could result. Actual damages shall be remedied and repaired to the Engineer's satisfaction.

I. Guarantee. All Work and material shall be fully guaranteed for a period of two (2) years from the dates of acceptance, against defects arising from faulty materials and/or workmanship. Accordingly, the Contractor shall promptly repair defects due to preparation, materials and workmanship, at its own expense, to the satisfaction of the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Tree Grates will be measured on a "per each" basis for each grate satisfactorily placed at locations designated on the Plans.

B. This item will be paid for at the Contract Unit Price per each for "tree grates", which price will be full payment for furnishing and installing of galvanized angles, anchor straps, tree grates and all hauling, all placing of materials, all painting, including touch-up and repairing of both the primer paint and final paint and all labor, equipment, tools and incidentals necessary to complete this item.

DIVISION 33
UTILITIES
33 00 00 UTILITIES

33 00 02 CORROSION CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

A. Installation of corrosion control components shall be in accordance with the following Specifications and Drawings. All installation practices and components shall be approved by the Engineer.

B. The corrosion control system for ductile iron pipe (this includes all piping, joints, valves, fittings, etc.) includes where shown on the Drawings: insulating corporation stops, insulating flanges, insulating couplings, insulating casing spacers, casing end seals, electrical continuity (joint bonding), sacrificial anode (magnesium) groundbeds, and corrosion control test facilities.

C. The corrosion control/corrosion monitoring system for prestressed concrete pipe includes all piping, joints, valves, fittings, etc., where shown on the Drawings: insulating corporation stops, insulating flanges, insulating couplings, insulating casing spacers, casing end seals, electrical continuity (joint bonding), sacrificial anode (zinc) groundbeds, an external protective coating, and corrosion control test facilities. The limits of the prestressed concrete pipe to be externally coated are shown on the Drawings. Prestressed concrete cylinder pipe must be fabricated with bonding plates (two (2) per pipe joint) for connection of joint bond wires as shown on the Drawings. Prestressed concrete embedded cylinder pipe must be fabricated with steel shorting straps and bonding plates (two (2) each per pipe joint) for connection of joint bond wires as shown on the Drawings.

D. Upon completion of the Work, the Engineer shall test, operate, inspect, and survey the installed Work. Any and all repairs or replacement of defective or improperly installed corrosion control/corrosion monitoring systems shall be corrected by the Contractor at no additional cost to the City.

1.2 SUBMITTALS

A. Catalog cuts of all materials to be installed shall be required and shall be submitted for approval.

B. Pipe coating and handling procedures shall be required and shall be submitted for approval for externally coated prestressed concrete pipe.

1.3 REFERENCE STANDARDS

A. The following is a list of the publications referenced in this Section.

1. American Society for Testing and Materials (ASTM)
2. ASTM A48 Specification for Gray Iron Castings
3. ASTM B418 Specification for Cast and Wrought Galvanic Zinc Anodes.

B. American Water Works Association (AWWA)

AWWA C210 AWWA Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

C. Society of Protective Coatings (SSPC)

SSPC SP3 Surface Preparation Specification No. 3, Power Tool Cleaning

PART 2 PRODUCTS

2.1 ANODES

A. Prepackaged Magnesium Anodes

1. Each magnesium anode shall have a nominal weight as shown on the Drawings. The anode size and weight shall be as follows:

   a. Seventeen (17) Pound Anodes: The anode shall weigh seventeen (17) pounds, excluding backfill. The anode shall be twenty-five inches (25″) long and D-shaped two and one-half inches by three and one-half inches by three and one-half inches (2.5″ X 3.5″ X 3.5″).
   b. Twenty (20) Pound Anodes: The anode shall weigh twenty (20) pounds, excluding backfill. The anode shall be fifty-eight and three-quarters inches (58.75″) long and D-shaped two and one-half inches by two and one-half inches by two and three-eighths inches (2.5″ X 2.5″ X 2.375″).
   c. Forty eight (48) Pound Anodes: The anode shall weigh forty-eight (48) pounds, excluding backfill. The anode shall be thirty and one-quarter inches (30.25″) long by five and one-quarter inches (5.25″) wide by five and three-quarter inches (5.75″) high).

2. Composition of the magnesium anode shall be as follows:

Aluminum	0.010% Maximum
Manganese	0.50 to 1.30%
Copper	0.02% Maximum
Nickel	0.001% Maximum
Zinc	0.05% Maximum
Iron	0.03% Maximum
Silicon	0.05% Maximum
Other	0.05% each or 0.30% Maximum Total
Magnesium	Remainder

3. The seventeen (17) and twenty (20) pound anodes shall be vibratory packaged in a permeable cardboard box of the following dimensions:

   a. Seventeen (17) Pound Anodes: The anode package shall be thirty-two inches (32″) long by five and one-half inches (5.5″) wide by five and one-half inches (5.5″) tall.

b. Twenty (20) Pound Anodes: The anode package shall be seventy-one inches (71″) long by four and one-half inches (4.5″) wide by four and one-half inches (4.5″) tall.

4. The forty-eight (48) pound anodes shall be vibratory packaged in a permeable cotton bag that shall be thirty-six inches (36″) long by nine inches (9″) in diameter.
5. The cardboard box containing the seventeen (17) and twenty (20) pound anodes shall contain a minimum of twenty-eight (28) pounds of backfill for seventeen (17) pound anodes, and forty-five (45) pounds of backfill for twenty (20) pound anodes.
6. The cotton bag for the forty-eight (48) pound anodes shall contain a minimum of fifty-seven (57) pounds of backfill. The backfill material shall have the following composition:

Hydrated Gypsum	75%
Bentonite	20%
Sodium Sulfate	5%

7. The magnesium anode and backfill shall be prepackaged into a single unit, in a vibrated cardboard box or bag as specified above. The box for seventeen (17) and twenty (20) pound anodes shall contain centering devices to maintain the anode in a centered position surrounded fully by the special backfill. A minimum of twenty feet (20′) of AWG No. 12 solid copper wire with TW insulation (black) shall be attached to the anode. Wire to anode attachment shall be by silver solder and sealed to prevent any moisture penetration.

B. Magnesium Ribbon Anodes

1. Each magnesium ribbon anode shall have a nominal weight of one-quarter (0.24) pounds per foot. The anode shall be three-quarters inches (0.750″) wide, three-eighths inches (0.375″) tall and be supplied in continuous one thousand (1,000) foot coils. The anode shall be manufactured with a steel core wire of one-eighth inch (0.125″) in diameter.
2. Composition of magnesium ribbon anode shall be as follows:

Aluminum	0.010% Maximum
Manganese	0.50 to 1.30%
Copper	0.02% Maximum
Nickel	0.001% Maximum
Zinc	0.05% Maximum
Iron	0.03% Maximum
Silicon	0.05% Maximum
Other	0.05% Each or 0.30% Maximum Total
Magnesium	Remainder

C. Prepackages Zinc Anodes

1. Each zinc anode shall have a nominal weight as shown on the Drawings. The anode size and weight shall be as follows:

a. Thirty (30) Pound Anodes: The anode shall weigh thirty (30) pounds, excluding backfill. The anode shall be sixty inches (60″) long by one and four-tenths inches (1.4″) wide by one and four-tenths inches (1.4″) tall.

b. Forty-five (45) Pound Anodes: The anode shall weigh forty-five (45) pounds, excluding backfill. The anode shall be forty-five inches (45″) long by two inches (2″) wide by two inches (2″) tall.

c. 60 Pound Anodes: The anode shall weigh sixty (60) pounds, excluding backfill. The anode shall be sixty inches (60″) long by two inches (2″) wide by two inches (2″) tall.

2. The zinc alloy shall meet the requirements of ASTM B418, Type II with a minimum potential of one and one-tenth (1.10) volts to a copper/copper sulfate reference electrode. The anode shall conform to the following composition:

Aluminum	0.005% Maximum
Cadmium	0.003% Maximum
Copper	0.002% Maximum
Iron	0.0014% Maximum
Lead	0.003% Maximum
Other	0.001% Maximum total for all others
Zinc	Remainder

3. The zinc anode, regardless of weight, shall be vibratory packaged in a permeable cardboard box (minimum seventy-one inches (71″) long by four and one-half inches (4.5″) on each side) filled with backfill of the following composition:

Hydrated Gypsum	75%
Bentonite	20%
Sodium Sulfate	5%

4. The zinc anode and backfill shall be prepackaged into a single unit, in a vibrated cardboard box. The box shall contain centering devices to maintain the anode in a centered position surrounded fully by the special backfill. A minimum of twenty feet (20′) of AWG No. 12 solid copper wire with TW insulation (black) shall be attached to the anode. Wire to anode attachment shall be by silver solder and sealed to prevent any moisture penetration.

D. ZINC RIBBON ANODES

Zinc ribbon anodes shall have an approximate weight of six-tenths (0.6) lbs/ft and shall be one-half inch (1/2″) by nine-sixteenths of an inch (9/16″) in cross section. The anode shall be continuously extruded over a wire core of thirteen-hundredths of an inch (0.13″) centrally located in the zinc alloy. The zinc alloy shall meet the requirements of ASTM B418, Type II.

2.2 REFERENCE ELECTRODES

A. Copper/Copper Sulfate Reference Electrode

The reference electrode shall be a permanent copper-copper sulfate reference electrode designed for a minimum twenty (20) year life. The electrode shall have a two inch (2″)

diameter by eight inches (8″) long, schedule 80 PVC body or a two inch (2″) diameter by seven inches (7″) long, high impact resistant Lexan tube, and a minimum overall package size of six inch (6″) diameter by ten inches (10″) long. The reference electrode shall be prepackaged in a permeable cloth bag with special copper-copper sulfate reference electrode backfill. Lead wire shall be of sufficient length to reach the test station terminals without splicing. The lead wire shall be AWG No. 14 stranded copper wire with either HMWPE or RHH-RHW insulation. The wire insulation shall be black. The lead wire shall be attached to the electrode core with the manufacturer's standard connection. The connection shall be stronger than the wire. No splicing of the reference electrode lead wire shall be permitted under any circumstances.

B. Silver/Silver Chloride Reference Electrodes

The reference electrode shall be a permanent silver-silver chloride reference electrode designed for a minimum twenty (20) year life. The electrode shall have a two inch (2″) diameter by eight inches (8″) long, schedule 80 PVC body or a two inch (2″) diameter by seven inches (7″) long, high impact resistant Lexan tube, and a minimum overall package size of six inches (6″) diameter by ten inch (10″) long. The reference electrode shall be prepackaged in a permeable cloth bag with special silver-silver chloride reference electrode backfill. Lead wire shall be of sufficient length to reach the test station terminals without splicing. The lead wire shall be AWG No. 14 stranded copper wire with either HMWPE or RHH-RHW insulation. The wire insulation shall be black. The lead wire shall be attached to the electrode core with the manufacturer's standard connection. The connection shall be stronger than the wire. No splicing of the reference electrode lead wire shall be permitted under any circumstances.

2.3 TEST STATIONS

A. The flush mount test station shall consist of a nonconductive terminal board mounted in a locking cast iron lid and collar (suitable for placement in heavy traffic areas) and a plastic shaft. The test station shall pass U.S. DOT H-20 roadway load test. The cast iron of the lid and collar shall meet or exceed ASTM A48 Class 25 Specification. The test station lid is to be made of cast iron with B-DPW cast into the lid design and painted yellow. The lid shall feature a cast in pentagonal bolt to lock into the cast iron cover. The cast iron collar to be at least two and three-quarters inches (2.75″) high with lugs cast inside to accept the locking lid and to accept a one inch (1″) cast iron repaving adapter with original lid. The plastic shaft is to be made of ABS (acrylonitrile butadiene styrene), eighteen inches (18″) long with a flared bottom to resist sinking in soil. The plastic shaft shall have a five inch (5″) inner diameter. The plastic shaft is to be riveted to the cast iron collar. The test block shall be made of nonconductive PVC (polyvinyl chloride) plastic. The terminal board shall contain a minimum of seven (7) terminals, using one-quarter inch (0.25″) by twenty (20) thread nickel plated machine screws and nuts. The terminal board shall fit into the lid using hangers cast inside the lid.

B. Test Station Concrete for the flush mounted test station slabs shall be Baltimore City Standard Mix #2 in accordance with the Standard Specifications.

C. Test Station Terminal Lugs shall be one (1) hole, compression terminal lugs for one-quarter inch (0.25″) bolt size.

2.4 CURRENT MEASURING SHUNT

Test station shunts shall be constructed to fit terminal posts for the specified test station. The resistance shall be point zero one (0.01) ohm with a current capacity of eight (8) amperes.

2.5 ELECTRICAL TAPE

Vinyl splicing tape and rubber splicing tape shall have a conformable water tight sealant and shall have a dielectric strength not less than fifteen (15) kV for a one-eighth inch (1/8″) thick layer.

2.6 WIRE

A. All wiring, excluding wire provided with the anodes or reference electrodes, shall be stranded copper wire of the AWG wire size and color shown on the Drawings.

B. Wire for test lead connections to the piping shall be single conductor, stranded copper wire with six hundred (600) volt THWN insulation. The wire sizes and colors shall be as shown on the Drawings.

C. Wire for bonded joints shall be single conductor, stranded copper with high molecular weight polyethylene (HMWPE) insulation (black). Wire size shall be AWG No. 2 for piping larger than thirty-six inch (36″), AWG No. 4 for sixteen inch (16″) to thirty-six inch (36″) piping, and AWG No. 6 for piping twelve inch (12″) and smaller.

D. Wire for anode header cables shall be single conductor, stranded copper with high molecular weight polyethylene (HMWPE) insulation (black). Wire size shall be AWG No. 8.

2.7 THERMITE WELD EQUIPMENT

Thermite weld molds and charges shall be suitable for the sizes and types of materials and shapes encountered. Adapter sleeves shall be utilized for all thermite welds.

2.8 INSULATING DEVICES

A. Insulating Flange Components

Insulating materials shall include an insulating gasket, insulating sleeves and insulating washers. The insulating gasket shall be Type “E”, neoprene faced phenolic. The insulating sleeves shall be one-thirty second inch (1/32″) spiral wound mylar sleeves. The insulating washers shall be one-eighth inch (1/8”) thick phenolic and installed on both sides of the flange. Steel washers shall also be used between the insulating washers and the bolts and nuts. The pressure rating for the insulating flange materials shall be greater than the design pressure of the piping.

B. INSULATING COUPLINGS

1. The insulating materials shall include an insulating gasket and a “full boot” plastic tubular insulator inside the middle ring to prevent contact of pipe ends isolated from one another. The insulating gasket shall have a skirt which extends under the follower

ring to insulate the follower ring from the pipe. The insulating gasket shall be rubber compounded material that will not deteriorate from age or exposure to air under normal storage or use. The rubber in the gasket shall meet the following Specification:

a. Durometer hardness: seventy-five (75) plus or minus five (±5).
b. Tensile strength: fifteen hundred (1,500) psi minimum.
c. Elongation: one hundred seventy-five percent (175%) minimum.
d. Electrical resistance: ten thousand (10,000) megohms.

2. The follower ring insulators and pipe end separators shall meet the following Specifications:

a. Water absorption: six point seven percent (6.7%) maximum.
b. Tensile strength: seventy-five hundred (7,500) psi minimum.
c. Electrical resistance: ten thousand (10,000) megohms.

C. Insulating Corporation Stops for the small, two inch (2″) and less in diameter, water services shall consist of a brass fitting with an inert nylon insulator and O-ring seal to assure a positive seal. The O-ring seal shall be retained in a groove to prevent O-ring loss if tailpiece is removed. The nylon insulator shall have high dielectric, compressive, and impact strength. The insulator skirt shall be extra long to resist electrical bridging or shorting. The brass parts of the corporation stop shall be designed to absorb tensile and bending forces from piping. The insulating corporation stop shall be provided with a beveled flange to increase compressive bearing area for added strength.

2.9 COMPRESSION CONNECTORS

Compression connectors shall be specifically manufactured for splicing copper cables together. The connectors shall be copper.

2.10 COATINGS

A. Coating for thermite welds to cast iron and to ductile iron pipe

1. Thermite welds to cast iron and to ductile iron piping are to be coated with a prefabricated assembly specially designed for covering cathodic protection wire connections to piping and fittings. The prefabricated assembly shall consist of the following components:

a. Top plastic sheet formed with an igloo shaped dome and entry tunnel for the lead wire;
b. A special elastomeric compound in the plastic dome firm enough to resist flow at normally encountered application and operating temperatures, but soft enough to mold itself around and completely cover the irregular welded profile;
c. A double row of parallel, flexible serrations on either side of the dome to assist with conforming around small diameter pipe;
d. A base of black unbacked elastomeric tape with exceptional adhesive properties for bonding firmly to a surface when used with the appropriate primer.
e. The appropriate primer as required by the elastomeric cap manufacturer shall be used.

B. Coating for thermite welds to PCCP shall be coated with a brush applied mastic (ten (10) mil minimum thickness) and embedded in the concrete mortar. The cold applied mastic shall have a high electrical resistivity (2.12 X 10^{13} ohms-cm) and fifty-eight and six-tenths percent (58.6%) solids by volume.

C. Coating for insulating flanges, insulating couplings and insulating corporation stops.

1. Insulating flanges, insulating couplings, and insulating corporation stops shall receive an exterior tape wrapping in the field. The coating applicator must abide by and follow all manufacturers' application Specifications for the coating system. All components of the coating system shall be manufactured by a single supplier to assure compatibility of individual components.

a. Primer: A soft brown primer containing moisture displacing corrosion inhibiting compounds for application by stiff brush or gloved hand at normal ambient temperature. The primer shall have the following properties:

1) Solids content: ninety-eight percent (98%).
2) Specific gravity: one and eight-hundredths (1.08).
3) Specific volume: fifty-six (56) cu in/lb.

b. Filler Mastic: A cold applied self supporting molding mastic. It shall be a petrolatum compound containing beads of closed cell cellular polymer and flow control additives. The filler mastic shall have the following properties:

1) Solids content: one hundred percent (100%).
2) Specific gravity: six hundred five thousandths (0.605).
3) Specific volume: forty-five and nine-tenths (45.9) cu in/lb.
4) Filler mastic shall be used at all irregular surfaces to provide a smooth surface for the application of the innerwrap and outerwrap.

c. Innerwrap: A nonwoven synthetic fabric carrier, fully impregnated with a neutral compound based on saturated petrolatum and inert siliceous fillers. The inner tape shall have the following properties:

1) Thickness: forty-six (46) mil.
2) Breaking strength: twenty-two and five tenths (22.5) lb/ sq. ft.
3) Water vapor transmission: six thousands (0.006) perms avg.
4) Resistance to cathodic disbonding: twenty-eight hundredths (0.28) sq. in. avg.
5) Tape width: eight or twelve inches (8″ or 12″).

d. Outerwrap: A plasticized polyvinyl chloride sheeting coated on one side with a rubber resin, pressure sensitive adhesive. The outerwrap shall have the following properties:

1) Thickness: ten (10) mil.
2) Breaking strength: twenty-five (25) lb/ sq. ft.
3) Tape width: six inches (6″).

D. External coating system for prestressed concrete pipe.

1. The external coating for the prestressed concrete piping shall be a polyamide epoxy coal tar, minimum twenty (20) mil thickness. The coating shall be a high build corrosion resistant coating that provides one (1) coat protection for concrete or steel in underground conditions. The coating shall conform to the performance requirements of AWWA C210.
2. All components of the coating system shall be manufactured by a single supplier to assure compatibility of individual components.

E. Mastic Coating

1. The field applied external coating shall be a cold applied mastic with the following properties:

   a. Composition: A pyrobituminous resin processed by homogenization with inhibitive pigments and aromatic solvents.
   b. Electrical volume resistivity: 2.12 X 10^{13} ohms-cm.
   c. Percent solids: fifty-eight and six tenths percent (58.6%) by volume, sixty-eight and two tenths percent (68.2%) by weight.
   d. Service temperature: zero to two hundred fifty degrees (0° to 250°) F.
   e. Weight per gallon: nine and forty-two hundredths (9.42) pounds.
   f. Specific gravity: one and thirteen hundredths (1.13).
   g. Flash point: forty-four degrees (44)° F seta closed cup.
   h. Color: black.

2. The mastic coating shall be applied only where specifically required by the Specifications.

2.11 LINKED RUBBER SEAL

The linked rubber seal shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annual space between the pipe and the wall opening. Each link shall have a permanent identification of the size and manufacturer's name on it. The bolts and flange hex nuts shall be 316 stainless steel with a eighty-five thousand (85,000) psi average tensile strength.

2.12 SEPARATOR MESH FOR FOREIGN LINE CROSSINGS

The separator mesh shall be a medium density flexible polyethylene webbing pad (mesh pattern), nominal thickness five-thirty seconds of an inch (0.156″).

2.13 INSULATED CASING SPACERS

Insulated casing spacers shall be fusion coated, twelve inches (12″) wide steel band with two inches (2″) wide glass reinforced runners. Insulated casing spacers shall be sized in accordance with the casing insulators (spacers) manufacturer's recommendations.

2.14 CASING END SEALS

Casing end seals shall be made of one eighth-inch (1/8″) thick rubber and shall be full conical in shape. The casing end seal shall be configured to the exact dimensions of the

piping and casing. The rubber end seals shall fully enclose the end of the casing and shall be water tight.

PART 3 EXECUTION

3.1 APPLICATION OF EXTERNAL COATING SYSTEM FOR PRESTRESSED CONCRETE PIPE

A. Buried prestressed concrete pipe, fittings, specials and closures shall receive an exterior coating in the pipe manufacturer's shop or at a separate applicator"s facility. The piping shall be externally coated only within the limits shown on the Drawings.

B. The coating applicator, regardless of the location where the coating is applied, shall be certified as qualified by the coating manufacturer. The coating applicator must abide by and follow all manufacturer's application Specifications for the coating system.

C. The prestressed concrete piping will be allowed to cure prior to coating in accordance with the coating manufacturer's requirements. The concrete surface shall then be brush-off blasted in accordance with the piping manufacturer's instructions. The pipe shall then be coated with the polyamide epoxy coal tar coating. The coating shall be applied in sufficient thickness to assure a minimum dry film thickness of twenty (20) mil. The coating will be applied to all external pipe surfaces in the area where coating is required.

D. The pipe manufacturer or coating applicators, as appropriate, will test and certify the exterior coating prior to shipping. When the pipe arrives at the job site, the Contractor shall visually inspect the pipe and repair any and all damage as directed by the coating manufacturer and in accordance with these Specifications.

E. Immediately prior to installation of the pipe, the Contractor shall inspect all exterior coatings on pipe, fittings, specials and closures for holidays and other defects. Field inspection of the exterior coating system shall be visual. All holidays and defects shall be repaired by the Contractor as directed by the coating manufacturer and in accordance with this Specification, and to the satisfaction of the Engineer.

3.2 FIELD REPAIRS OF EXTERNAL COATING SYSTEM FOR PRESTRESSED CONCRETE PIPE

Shop applied coatings that are damaged in transit or during handling shall be repaired prior to backfilling. The field applied repair coatings shall be as recommended by the shop applied coating manufacturer and shall be entirely compatible with the original coating system. The field coating repairs shall be performed in accordance with all recommendations of the coating manufacturer.

3.3 FIELD COATING OF PRESTRESSED CONCRETE PIPE JOINTS AND SPECIAL FITTINGS

Field joints and special fittings shall be coated in accordance with the recommendations of the coating manufacturer.

3.4 TRANSPORTATION, HANDLING AND STORAGE OF COATED PIPE

A. Pipe shall be handled in such a manner as to protect the pipe and the coating from damage.

B. At the pipe manufacturer's plant, if forklifts are used, all bearing surfaces of a forklift apparatus must be padded with suitable padding material. Web slings may also be used at the pipe manufacturer's plant.

C. At the project site, the pipe shall only be handled with slings. Metal chains, cables, tongs, forklifts or other equipment likely to cause damage to the coating, will not be permitted. Web slings shall be a type that will not damage the coating. When the pipe is handles with slings, there should be a minimum of two (2) slings. Slings should be a minimum of 18 inches (18″) wide and of sufficient strength to handle the weight of the piping safely. Slings shall not pass through the pipe. Hooks on the end of the pipe will not be allowed. Handling equipment, materials, and procedures shall be submitted to the Engineer for approval. If possible, the pipe should be handled from cutback ends.

D. Storing of the coated pipe shall be on padded skids, minimum one-half inches (1/2″) wide, or select loamy or sand dirt berms, or suspended from cutback ends, where possible. In urban areas, pipe should be suspended on padded skids or skids placed at cutback areas. Where skid chucks are used in contact with coated pipe, they should be padded with several layers of carpeting. Padded chucks should be placed such that coated pipe is nested on the skid rather than the chuck. Coated pipe shall not be laid on pavement without benefit of padding at contact points. In preparation for transporting pipe, the use of web slings is necessary for tie downs.

E. If cables or chains are used during transportation, they must be properly padded with approved, suitable material as required to protect the coating from damage while in transit. Use of a padded horizontal separator strip between successive rows of pipe is necessary to prevent damage to the pipe coating, i.e.: strips of rug material over all contact areas where pipe will rest.

3.5 PROTECTION OF COATING SYSTEMS DURING CONSTRUCTION

A. At all times during construction of the pipeline, the Contractor shall take every precaution to prevent damage to the protective coating. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workman shall not be permitted to walk on the coating, except when absolutely necessary and when approved by the Engineer, in which case, the Contractor shall wear shoes with rubber or composition soles and heels or other suitable footwear which will not damage the coating.

B. Pipe shall be hoisted from the trench side to the trench by means of a minimum of two (2), eighteen inch (18″) wide belt slings of sufficient strength to handle the weight of the piping safely. Dragging or skidding of pipe on grade or in the trench shall not be permitted.

C. Any and all coating damage shall be repaired with specified coating repair materials prior to installation.

3.6 THERMITE WELDING

A. All thermite welds shall be made as shown on the Drawings and in accordance with the manufacturer's recommendations using the proper combination of equipment for the pipe and wire size being welded. All welding materials and equipment shall be the product of a single manufacturer.

B. Assure that the area where the attachment is to be made is absolutely dry. Remove mill coating, dirt, grime and grease from the pipe or fitting surface at the weld location by wire brushing or by the use of suitable safety solvents. Clean a three inch (3″) square area of the pipe or fitting surface at the weld location to a bright shiny surface, free of all serious pits and flaws by use of a mechanical grinder.

C. Prepare the wire for welding by assuring that the cable is absolutely dry. The cable shall be free of dirt, grease and other foreign products. Cut the cable in such a way as to avoid flattening or forcing out of round. To prevent deformation of the cable, cut the cable with cable cutters. Remove the insulation in a manner that will avoid damage to strands. Install adapter sleeves for all bonds and test wires prior to welding. Either prefabricated factory sleeved joint bonds or bond wire with formed sleeves made in the field are acceptable. Hold the cable at an approximate thirty degrees (30°) angle to the pipe surface when welding.

D. When the weld has cooled, remove the weld slag and test the weldment for strength by striking a sharp blow with a two (2) pound hammer while pulling firmly on the wire. Reweld unsound welds and retest weldments. Thoroughly clean mold and mold covers after completion of each weld to assure that no slag will penetrate into the next weld.

E. After soundness of the weld has been verified, thoroughly clean with a stiff wire brush and coat.

1. Thermite welds to cast iron and to ductile iron pipe shall be coated with a plastic cap filled with elastomeric material. The elastomeric cap shall extend on all four (4) sides beyond the cleaned area. Apply primer over the entire weld area and over the entire area where the elastomeric cap will be placed. Push the dome of the prefabricated cap containing elastomeric material firmly into weld area. Lift the wire away from the pipe and apply the elastomeric material completely around and underneath the wire. Push the wire back down on the pipe. Follow all manufacturer's instructions for installing prefabricated caps.

2. Thermite welds to prestressed concrete pipe shall be coated with a brush applied mastic (ten (10) mil minimum thickness). The mastic shall cover the entire area of the weld and the steel bonding plate. The mastic shall be allowed to completely dry before fully embedding within concrete mortar at the pipe joint. Follow all manufacturer's instructions for applying mastic coating.

3.7 BONDED JOINTS

A. All new pipeline joints, including those on pipe, fittings, valves and branch connections, except those specified to be insulated, shall be bonded as shown on the Drawings and according to the manufacturer's recommendations, using the proper combination of

equipment for the pipe and wire size being welded. All bond cables shall be thermite welded to the pipe or fitting as described above.

B. All joints are to be bonded with two (2) insulated copper cables. Wire size shall be AWG No. 2 for piping larger than thirty-six inch (36″) AWG No. 4 for sixteen inch (16″) to thirty-six inch (36″) piping, and AWG No. 6 for piping twelve inch (12″) and smaller.

C. All thermite weld connections shall be coated as specified in Paragraph 3.6.E.

D. Bond cables installed around vaults shall be direct buried.

3.8 PREPACKAGED MAGNESIUM ANODES

A. Prepackaged magnesium anodes shall be installed where indicated. Prior to installation, remove all shipping covers from the anode (the prepackaged box shall not be removed). Install the anodes in existing soils (free from rocks, roots, organic material, trash or other debris) and backfill with existing soil (as described above). Do not install the anode in sand, rock or gravel backfill. Provide a minimum anode spacing of two feet (2′) from other pipelines. Presoak the anode in water after placement, but prior to backfilling.

B. Anode lead wires shall be buried a minimum of two feet (2′) below grade. Handle wire with care. Splice the AWG No. 12 solid copper wire supplied with the anode to an AWG No. 8 HMWPE stranded copper cable through the use of a compression connector as shown. Tape the splice with three (3) layers of high voltage rubber splicing tape fifty percent (50%) overlap, followed by three (3) layers of vinyl electrical tape fifty percent (50%) overlap. Terminate the ends of the AWG No. 8 anode header cable in the test stations as shown on the Drawings.

3.9 PREPACKAGED ZINC ANODES

A. Prepackaged zinc anodes shall be installed where indicated. Prior to installation, remove all shipping covers from the anode (the prepackaged box shall not be removed). Install the anodes in existing soils (free from rocks, roots, organic material, trash or other debris) and backfill with existing soil (as described above). Do not install the anode in sand, rock or gravel backfill. Provide a minimum anode spacing of (2′) feet from other pipelines. Presoak the anode in water after placement, but prior to backfilling.

B. Anode lead wires shall be buried a minimum of two feet (2′) below grade. Handle wire with care. Splice the AWG No. 12 solid copper wire supplied with the anode to an AWG No. 8 HMWPE stranded copper cable through the use of a compression connector as shown. Tape the splice with three (3) layers of high voltage rubber splicing tape fifty percent (50%) overlap, followed by three (3) layers of vinyl electrical tape fifty percent (50%) overlap. Terminate the end of the #8 AWG anode header cable in the test stations as indicated.

3.10 ZINC AND MAGNESIUM RIBBON ANODES

A. Zinc and magnesium ribbon anodes shall be installed where shown on the Drawings. Maintain a minimum of twelve inches (12″) of separation between the pipe and the anode. Backfill around the anode ribbon shall be thoroughly compacted with a six inch (6″)

minimum cover. The backfill material shall be native soil that is free of roots, organic material, trash and rocks. Do not backfill the anode with sand, rock or gravel.

B. Attachment of the anode lead wires to the ribbon anodes shall be made by removing the anode material from the iron core and installing a compression connector around the wire and the anode core. Follow the anode manufacturer's instructions for removing the anode material from the core. Tape the splice with three (3) layers of high voltage rubber splicing tape fifty percent (50%) overlap, followed by three (3) layers of vinyl electrical tape fifty percent (50%) overlap. Lead wires shall be attached to the anode at locations shown on the Drawings. The lead wires shall be terminated with terminal lugs in test stations as indicated. Direct connection of the ribbon anode to the pipe will not be acceptable.

C. Anodes shall be continuous between test stations. Anode splices shall be allowed and shall be made by removing the anode material from the iron core and installing a compression connector around the two (2) iron cores of the adjacent anodes. Tape the splice with three (3) layers of high voltage rubber splicing tape fifty percent (50%) overlap, followed by three (3) layers of vinyl electrical tape fifty percent (50%) overlap.

3.11 TEST STATIONS

A. Install test stations at the locations indicated on the Drawings. Test stations are to be located directly over the pipeline, except where shown on the Drawings, at the side of the road. When test stations are shown at the side of the road, route the test station wiring inside conduit to the final test box location.

B. Attach test wires as indicated using the proper thermite welding equipment and charges specified for the wire size and respective pipe material. Follow all procedures as outlined above.

C. All test station wires shall be routed a minimum of two feet (2′) below finished grade. Maintain sufficient slack in the test wires so that the wires can extend a minimum of eighteen inches (18″) from the test station. Connect the test wires to the test station terminal board with one (1) hole compression terminal lugs for one-quarter inch (0.25″) bolt size.

D. The test stations shall be set even with final grade in poured concrete, two feet (2′) on each side and six inches (6″) thick reinforced with four inch (4″) by four inch (4″) W2.1 by W2.1 welded wire fabric. The flush mounted test station lids shall be free of concrete and not cemented over.

3.12 REFERENCE ELECTRODES

Install reference electrodes at the test stations indicated. The reference electrode shall be installed within the pipeline trench excavation at an approximate depth of six inches (6″) below the bottom of the pipe and at a distance of approximately six inches (6″) from the centerline of the pipe. Native trench material shall be used to backfill the reference electrode for a minimum of six inches (6″). Prior to installation, remove the plastic shipping cover from the reference electrode. The cloth bag containing the special backfill shall remain intact.

3.13 CLEARANCE TO OTHER STRUCTURES

Twelve inches (12″) of natural clearance shall be maintained to other structures, where possible. When twelve inches (12″) of clearance cannot be maintained, install a flexible polyethylene mesh webbing pad around the new piping and secure with nonmetallic tape.

3.14 CONCRETE STRUCTURES

Position reinforcing rods used in the construction of concrete structures so that they are not in contact with the piping. Maintain a minimum two inch (2″) spacing between all reinforcing steel and the pipe and any pipe anchors. Wall penetrations require special link seal facilities designed to insure electrical isolation between pipe and the concrete and its reinforcing steel.

3.15 FOREIGN LINE CROSSINGS

Twelve inches (12″) of natural clearance shall be maintained to other pipes, where possible. When twelve inches (12″) of clearance cannot be maintained, install a medium density flexible polyethylene mesh pattern webbing pad, nominal thickness five-hirty seconds inch (0.156″), around coating and secure with nonmetallic tape.

3.16 CONCRETE BUTTRESSES, SUPPORT BLOCKS, ANCHOR BLOCKS, THRUST BLOCKS

A. Position reinforcing rods used in the construction of support blocks, anchor blocks, thrust blocks, and other concrete structures so that they are not in contact with the piping. A minimum of two inches (2″) of clearance is required between the piping and the reinforcement steel.

B. Apply two (2) coats (each coat a minimum of ten (10) mil in thickness) of a mastic coating to ductile iron pipe and fittings that will be in direct contact with poured concrete underground. The mastic coating shall be applied in accordance with the coating manufacturer's recommendations and shall be allowed to fully dry before the concrete in placed in contact with the field coated pipe.

3.17 INSULATING FLANGES AND INSULATING COUPLINGS

A. Insulating flanges and insulating couplings shall be installed where indicated on the Drawings. The Contractor shall carefully align and install the insulating components according to the insulator manufacturer's instructions.

B. Before backfilling, each insulator shall be tested for electrical insulation. If the flange or coupling is not properly insulated, the Contractor shall, at its expense, repair or replace all defective components. The repaired insulator shall be tested. This process will continue until the flange or coupling is verified as being properly isolated.

C. After the flange or coupling is verified as being properly isolated, the insulator shall be coated with a tape coating as described below. Test wires and magnesium anodes shall be installed at the insulating flanges and insulating couplings as shown on the Drawings.

3.18 INSULATING CORPORATION STOPS

A. Insulating corporation stops shall be installed to isolate all two inch (2″) and smaller service connections to the water main. The Contractor shall carefully align and install the insulating components according to the insulator manufacturer's instructions.

B. Before backfilling, each insulator shall be tested for electrical insulation. If the corporation stop is not properly insulated, the Contractor shall, at its expense, repair or replace all defective components. The repaired insulator shall be tested. This process will continue until the corporation stop is verified as being properly isolated.

C. After the corporation stop is verified as being properly isolated, the insulator shall be coated with a tape coating as described in 3.19 below.

3.19 COATING OF INSULATING FLANGES, INSULATING COUPLINGS, AND INSULATING CORPORATION STOPS

A. The insulating flanges, insulating couplings, and insulating corporation stops, including all isolation components shall be fully coated prior to backfill. The insulating flanges, insulating couplings, and insulating corporation stops shall be coated for a minimum of twelve inches (12″) on either side of the flange, coupling, or corporation stop. The insulating flanges, insulating couplings, and insulating corporation stops shall be coated after verification of proper electrical isolation. The insulating flanges, couplings, and insulating corporation stops shall be coated as described below.

1. Clean the surface of the flange, coupling, or corporation stop and all of its components by power tool cleaning in accordance with the Steel Structures Painting Council SP3. Follow all surface preparation recommendations of the coating manufacturer.
2. Apply a uniform coat of the primer to the external surface of the flange, coupling, or corporation stop and all of its components including; bolts, nuts, etc. The primer shall extend a minimum of twelve inches (12″) on either side of the flange, coupling, or corporation stop.
3. Apply filler mastic to all irregular surfaces of the insulating flange, insulating coupling, or insulating corporation stop to assure a smooth profile for application of the inner tape coating.
4. Apply innerwrap to the insulating flange, insulating coupling, or insulating corporation stop and their components in a spiral fashion with a minimum overlap of fifty-five percent (55%). The innerwrap shall extend a minimum of twelve inches (12″) on either side of the flange, coupling, or corporation stop.
5. Apply outerwrap to the insulating flange, insulating coupling, or insulating corporation stop and their components in a spiral fashion with a minimum overlap of one inch (1″). The outerwrap shall be applied with sufficient tension to provide continuous adhesion of the outerwrap tape. Install test facilities at the insulating flange and insulating coupling as shown on the Drawings.

3.20 INSULATED CASING SPACERS AND CASING END SEALS

A. Each length of pipe within the casing shall be supported and electrically isolated from the casing by the use of a minimum of two (2) insulating casing spacers (supports). The number of casing spacers and the spacing between them shall be in accordance with the

recommendations of the casing spacers' manufacturer. The insulating spacers shall be of sufficient dimension to approximately center the carrier pipe within the casing and to serve as runners to slide the carrier through the casing.

B. After the carrier pipe is installed within the casing, the casing shall be tested to verify that it is electrically isolated from the carrier pipe. If the carrier pipe is not electrically isolated from the casing, the Contractor shall remove the carrier pipe, replace any and all damaged casing spacers and reinstall the carrier pipe in the casing. The casing shall be tested to verify that it is electrically isolated from the carrier pipe. This process will continue until the casing is verified as being electrically isolated from the carrier pipe.

C. After the casing is verified as electrically isolating, install rubber casing end seals at both ends of the casing in accordance with the manufacturer's recommendations. The casing end seals shall be water tight. Install test wires, reference electrodes and magnesium anodes as shown on the Drawings.

3.21 POST INSTALLATION TESTING

Prior to substantial completion, the City's Corrosion Engineer will perform post installation testing of all corrosion control/corrosion monitoring systems. The repair or replacement of any defective or improperly installed systems shall be the sole responsibility of the Contractor. Any and all repairs or replacement of defective or improperly installed corrosion control/corrosion monitoring systems shall be performed by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

The payment stated in the Bid price will be full compensation for all activities, materials, testing, etc., and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

33 05 00 COMMON WORK RESULTS FOR UTILITIES

33 05 16.13 PRECAST CONCRETE UTILITY STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

A. Precast concrete utility structures shall include, but not necessarily be limited to, furnishing and installing precast concrete storm drain structures, manholes, valve and meter vaults, grade rings, and other miscellaneous structures of the configuration and to the extent indicated and in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Trench excavation, backfill, and compaction, Section 31 23 33, (Trenching and Backfilling, Point Excavation and Backfill).
2. Storm drainage structure; Section 33 49 00 (Storm Drainage Structures).

3. Water valves and appurtenances, Section 33 12 16, (Water Valves and Appurtenances).
4. Water services, meter settings, and vaults, Section 33 12 00, (Water Services Water Meter Settings and Vaults).
5. Sanitary sewer manholes, Section 33 39 13, (Sanitary Utility Sewerage, Manholes, Misc. Structures, Frames and Covers).
6. Dampproofing and Membrane Waterproofing, Section 03 15 13, (Dampproofing and Waterproofing).

1.2 QUALITY ASSURANCE

A. Precast concrete utility structures shall be supplied by a qualified firm with a minimum of three (3) years of continuous operations and which has performed at least three representative jobs, three (3) years or older, comparable to precast Work required for this Contract.

B. The Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. Access shall be allowed the Engineer to the casting plant at any time to inspect the fabrication of units for City projects.

C. Precast units shall be substantially free of fractures and surface roughness. The planes of the ends of sections to be joined shall be perpendicular to their longitudinal axis within five-eighths inch (5/8″). Precast units shall be subject to rejection on account of failure to conform to any of the Specification requirements. In addition, individual sections may be rejected because of any of the following:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
2. Defects that indicate imperfect proportioning, mixing, and molding.
3. Surface defects indicating honeycombing or open texture.
4. Damaged or cracked ends, where such damage would prevent making a satisfactory joint.
5. Any continuous crack having a surface width of one-hundredths inch (0.01″) or more and extending for a length of twelve inches (12″) or more, regardless of position in the section or wall.
6. For grade rings, cracks or fractures extending for a length of one-half inch (1/2″) or more regardless of position in the ring. Dimensional tolerances shall be plus or minus one-quarter inch (± 1/4″).

D. Precast units shall be set so as to be vertical. The maximum allowable deviation, when measured from the top to the bottom of the completed unit, shall not exceed one-quarter inch (1/4″).

E. The manufacturer or supplier shall store completed sections off the ground with ample space between rows and enough clearance above and below to allow full view of walls and joint ends for inspection purposes.

F. The Engineer reserves the right to require core samples of finished products.

G. All precast units shall be marked with the manufacturer's name or trademark, date of manufacture, and the ASTM and/or AASHTO Specification under which the unit was manufactured.

1.3 SUBMITTALS

A. Shop Drawings shall be submitted as specified in 01 33 23, (Shop Drawings, Product Data and Samples) for all precast units. The shop drawings shall be fully dimensioned and show reinforcing, design loads, pertinent design calculations, and lifting and erection inserts. Shop Drawings shall also include the precast unit manufacturer's handling, assembly, and installation directions and recommendations.

B. Certificates of Compliance shall be submitted as specified in the 01 33 23, (Shop Drawings, Product Data and Samples), stating that the precast units furnished, and their components, meet the design, fabrication, and testing requirements specified in Sections 33 05 16.13, (Precast Concrete Utility Structures)

PART 2 PRODUCTS

2.1 MATERIALS

A. Contractor's Options

The Contractor may furnish A 312 Grade TP 410 Stainless steel or reinforced plastic steps composed of ASTM A615, Grade 60 reinforcing bar (#4) completely encapsulated in copolymer polypropylene per ASTM D2146, Type II, Grade 43758 for use in manholes, inlets, and vaults.

B. Detailed Material Requirements

1. Portland cement concrete shall meet the requirements specified in Section 03 30 00, (Portland Cement Concrete Structures), except as modified herein. Portland cement for units to be used in sanitary sewer systems shall be Type II.
2. Concrete Reinforcement shall meet the requirements specified in Section 03 21 00, (Reinforcing Steel).
3. Water from Other Than Potable Sources shall meet the pH requirements of AASHTO T 26, Method B. Water shall not smell or be discolored. Water suspected of questionable quality shall meet limits of the comparison tests with distilled water in accordance with AASHTO T 26.
4. The chloride concentration of water used in mixing and curing of Portland cement will be determined in accordance with ASTM D 512 and shall not have a chloride concentration exceeding one thousand (1000) ppm.

C. Joint Seals Between Sections

1. Flexible Joint Sealing Compound: Joint sealing material shall be cold applied preformed plastic sealing compound meeting the following requirements:

CHEMICAL COMPOSITION	MINIMUM	MAXIMUM	TEST METHOD
Bitumen (Hydrocarbon Plastic Content) % by weight	50	70	ASTM D4
Inert Mineral Filler % by weight	30	50	AASHTO T111
Volatile Matter % by weight	--	2.0	ASTM D6
PHYSICAL PROPERTIES			
Specific Gravity at 77° F	1.20 to 1.36		ASTM D71
Ductility at 77° F minimum	5.0 cm		ASTM D113
Softening Point at 77° F minimum	320° F		ASTM D36
Flash Point, C.O.C. minimum	600° F		ASTM D92-57
Penetration 77° F (150 gs.) 5 sec	50 to 120		ASTM D217

or shall be a specially formulated preformed joint sealant in rope like form which swells upon contact with water forming a compression type seal. See table below.

2. The specially formulated preformed joint sealant shall meet the following requirements:

CHEMICAL COMPOSITION	MINIMUM	MAXIMUM	TEST METHOD
Butyl Rubber Hydrocarbon % by weight	24.9		ASTM D297
Volatile Matter % by weight	below 1.0		ASTM D6
PHYSICAL PROPERTIES			
Specific Gravity at 77° F	1.57		—
Penetration	58		ASTM D217 150 GTL
	85		ASTM D217 300 GTL
Flash Point	365		ASTM D93-97
Accelerated Aging	Maintain 99% Solids		4 hrs @ 212 F
Storage Life	Indefinite		—
Application Temperature Range	5°F to 125° F		—
Service Temperature Range	−40°F to 212° F		—

3. Gaskets: Rubber gaskets shall meet the requirements of ASTM C 443.

D. Sanitary Sewer Manhole Materials

1. Flexible Gaskets Between Manhole and Frame: Flexible plastic gasket between manhole and manhole frame shall be extruded rope Type B, in accordance with AASHTO M 198, butyl based, three-quarters inch (3/4″) diameter minimum.
2. Jointing Mastic shall be an elastic, water resistant formulation of plastic bituminous materials and inert fillers so combined when applied to a vertical metal surface and heated to one hundred twenty degrees (120°) F, the jointing mastic will neither slump nor loose plasticity. When applied directly from the container, without further mixing, the jointing mastic can be applied in an even adherent coat within the temperature range of twenty degrees to one hundred degrees (20° to 100°) F.

3. Manhole to Pipeline Connectors: Unless otherwise indicated in the Contract Documents, flexible gasket connectors for connecting pipes to manholes shall meet the requirements of ASTM C923
4. Provide thermoplastic cast in place inserts with a working tensile load capacity of twelve hundred (1200) pounds for bolting down manhole cover frames where indicated on the Drawings. Inserts shall be one-half inch (1/2″) diameter by two and three-quarter inch (2-3/4″) minimum length.

E. Dampproofing and Waterproofing for exterior of precast structures shall be as specified in Section. 03 15 13, (Dampproofing and Waterproofing).

F. Steps and Ladders shall be A312 Grade TP 410 Stainless steel or reinforced plastic steps composed of ASTM A615, Grade 60 reinforcing bar (#4) completely encapsulated in copolymer polypropylene per ASTM D2146, Type II, Grade 43758

G. Granular Bedding beneath precast units shall meet the requirements of AASHTO, M 43, No. 57

H. Nonshrink Mortar: Quick setting nonshrink cement mortar shall be as specified in Section 03 62 00.01, (Nonshrink Grouting).

PART 3 EXECUTION

3.1 DESIGN CRITERIA

A. General

1. Structural design for precast units shall be prepared by a registered Engineer for the precast concrete manufacturer. Units shall be designed for HS 25 load designation or three hundred (300) pounds per square foot live load, whichever is most critical for determining the concrete and steel stresses.
2. Where more than one standard is referenced for any given unit, should there be a conflict, the more stringent requirement as determined by the Engineer, shall apply.
3. Unit configuration shall be as shown on the Plans and/or Standard Details.
4. Distribution of earth loading and live load shall be in accordance with ASTM C 857 or ASTM C 890.
5. Walls shall be designed using an equivalent fluid pressure of 83 pounds per cubic foot and a two foot (2′) surcharge. The units shall also be designed to resist all stress encountered during casting, handling, and erection.

3.2 MANHOLES

A. Precast concrete manholes shall meet the requirements of ASTM C 478 except that the minimum compressive strength of the concrete shall be 4000 psi.

B. Joints shall meet the requirements of ASTM C 443, shall be self centering, and shall form a uniform water tight joint.

3.3 INLETS

Precast inlets shall meet the requirements of AASHTO M 199.

3.4 GRADE RINGS

A. Grade rings shall meet the requirements of ASTM C 478 and shall be one (1) piece, two or three inches (2″ or 3″) thick, with anchors bolt holes as shown in the Standard Details.

B. Miscellaneous Water and Wastewater Structures not otherwise covered shall meet the requirements of ASTM C 913.

3.5 FABRICATION

A. The precast units shall be factory cast. Job site casting will not be permitted. Concrete in the precast elements shall be continuously placed to prevent formation of seams. The finished units shall be free of voids, cracks, and have beveled corners and edges. All inserts shall be securely attached or embedded in their property location.

B. Concrete strength of all precast units at twenty-eight (28) days shall be four thousand (4000) psi minimum, unless otherwise specified. It shall be the precast unit manufacturer's responsibility to insure that the specified concrete strength is maintained throughout production of the units. Mix design shall be those previously used by the manufacturer which have proven satisfactory for casting units similar to those specified and producing the required strength. All precast concrete shall be air entrained. Admixtures containing calcium chloride shall not be used.

C. Precast concrete units shall be manufactured in accordance with the applicable requirements of ASTM C 858, and as modified herein except that precast concrete units manufactured by the dry cast (packerhead) process are prohibited.

D. Wall sleeves or gaskets for piping, sumps, steps, access hatches, and other inserts as shown on the Plans and/or Standard Details shall be cast into the structure or inserted at the place of manufacture.

3.6 PRODUCT HANDLING

A. No precast unit shall be shipped in less than fifteen (15) days from date of manufacture, unless the unit has been tested and is shown to be in full compliance with the Specifications.

B. Precast sections shall be transported and handled with proper equipment to protect the elements from damage. Sections shall be handled by means of lifting inserts embedded in the concrete. Damaged sections that cannot be satisfactorily repaired shall be replaced by new sections at no additional cost to the City.

C. Precast sections shall be stored on wooden blocks to hold them off the ground to prevent dirt and debris from entering the joining surfaces.

3.7 INSTALLATION

A. Excavation, foundation preparation, backfill, and compaction shall be as specified in Section 31 23 33, (Trenching and Backfilling, Point Excavation and Backfill).

B. Precast units shall be installed where and as shown on the Plans and Standard Details or as directed by the Engineer.

C. Pipe connection, penetrations, and other appurtenances shall be installed as specified in the following sections:

1. Section 33 49 00, (Storm Drainage Structures).
2. Section 33 12 16, (Water Valves and Appurtenances).
3. Section 33 12 00, (Water Services, Meter Settings, and Vaults).
4. Section 33 39 13, (Sanitary Utility Sewerage Manholes, Miscellaneous Structures, Frames and Covers).

D. Field modifications of precast units, such as cutting or enlarging holes or slots, will not be permitted without the specific approval of the precast unit's manufacturer and the Engineer. Permitted modifications shall be made in strict accordance with the manufacturer's directions and recommendations.

E. Mating surfaces shall be cleaned of all foreign materials such as dirt, mud, stones, etc., and where appropriate, joint sealing materials applied prior to assembly of the units.

PART 4 MEASUREMENT AND PAYMENT

The precast concrete utility structures for storm drain and sanitary sewer structures, manholes, valve and meter vaults, and other miscellaneous structures will be measured and paid for at the Contract Unit Price as indicated for the applicable utility Section

33 11 00 WATER UTILITY DISTRIBUTION PIPING

33 11 13 PUBLIC WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 DESCRIPTION

This Section includes requirements, but shall not necessarily be limited to, furnishing and installing water pipes, fittings, appurtenances, test, and chlorinate water pipes for a water supply and distribution system including fire protection to the limits indicated in accordance with the Contract Documents.

1.2 RELATED WORK INCLUDED ELSEWHERE

A. Trenching and Backfilling, Point Excavation and Backfill, Section 31 23 33.

B. Patch Existing Pavement and Reset Utility Services, Section 32 01 30.10.

C. Water Valves and Appurtenances, Section 33 12 16.

D. Water Services, Water Meter Settings, and Vaults, Section 33 12 00.

E. Water Utility Distribution Fire Hydrants, Section 33 12 19.

F. Portland Cement Concrete Structures, Section 03 30 00.

G. Corrosion Control, Section 33 00 02

H. Cleaning and Lining Water Mains, Section 33 13 00.

I. Precast Concrete Utility Structures, Section 33 05 16.13

1.3 QUALITY ASSURANCE

A. The Engineer will inspect all materials before and after installation to ensure compliance with the Contract Documents. When specific tests of materials are called for in the referenced standards and Specifications, the Engineer has the option of requiring that any or all of these tests be performed for materials furnished for a specific project. When testing is required, it will be specified herein or in the "Special Provisions."

B. Ductile iron pipe (DIP) and fittings shall be sound and without defects and confirm to AWWA C151 or C153. Repair of defects by welding or other methods will not be allowed. Field cut and remove damaged section of pipe to six inches (6″) beyond damaged lining. Removal and replacement of rejected pipe, fittings, or appurtenances shall be at Contractor's expense.

C. Polyvinyl chloride (PVC) pipe and couplings shall be homogeneous throughout and free from visible cracks, bubbles, blisters, holes, foreign inclusions, cuts, or scrapes on inside or outside surfaces, or other imperfections, which may impair the performance or life of the pipe. Each pipe shall be straight to within one and one-quarter inch (1-1/4″) per twenty foot (20′) length of pipe when uniformly supported along its entire length, and shall have a true circular cross section to within plus or minus one sixty-fourth inch (± 1/64″). This pipe shall only be allowed in special applications of nonpotable/treated lines with prior City approval. PVC pipe manufactured more than six (6) months prior to work site inspection will not be accepted. Loading, unloading, handling, inspection and storage of PVC pipe shall be in accordance with AWWA C605. PVC pipe shall be stored such that it does not deform or bend.

D. High Density Polyethylene Pressure Pipe (HDPE): Any defective, damaged, or unsound pipe or appurtenance shall be rejected. At any point along the polyethylene pipeline where ten percent (10%) of the wall thickness has been penetrated or removed by way of marring, gouging or abrasion, then that damaged section of pipe will be deemed unsound and shall be removed and replaced with a new, clean section of polyethylene pipe.

E. Steel Pipe: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200, C205, and coating and lining standards as applicable.

1. Shop Testing of Steel Pipe

a. After the joint configuration is completed and prior to lining with cement/mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of seventy-five percent (75%) of the yield strength of the pipe steel.

b. Production weld tests shall be conducted in compliance with AWWA C200. In addition to the frequency of tests required in AWWA C200, weld tests shall be conducted on each two thousand feet (2,000') of production welds and at any other times there is a change in the welding procedure or welding equipment.

2. Shop Testing of Steel Plate Special

   a. Upon completion of welding, but before lining and coating, each special shall be bulkheaded and tested under a hydrostatic pressure of one and one-half (1-1/2) times the design pressure; provided, that if straight pipe used in fabricating the specials has been previously tested and meets the requirements of the applicable piping Section, no further hydrostatic testing will be required; or provided, that all other welded seams are tested by the liquid penetrant inspection procedure conforming to ASTM E165, under Method "B" and "Leakage Testing" or where applicable by the soap and compressed air method at an air pressure of twenty-five (25) psi. Any pin holes or porous welds which may be revealed by the test shall be chipped out and rewelded and the special retested.
   b. No outside coating shall be applied over a seam prior to testing; however, mortar lining may be applied over a seam prior to hydrostatic testing, but under such conditions said pressure test shall be held on the pipe or fitting for a period of not less than thirty (30) minutes.

3. Steel Pipe Tape Coating Tests:

   a. The Contractor shall make a visual inspection of steel pipe tape coating upon receipt from the supplier.
   b. The Contractor shall retain the services of an independent inspection firm that is qualified to perform discontinuity (Holiday) testing in accordance with the requirements of NACE Standard RP0188.
   c. Immediately prior to placing steel pipe into the trench, a discontinuity (Holiday) test shall be performed on the pipe coating.
   d. All repaired holidays shall be retested in accordance with the requirements of NACE Standard RP0188.
   e. The Engineer may elect to perform random discontinuity (Holiday) testing.
   f. Prepare a certification of the discontinuity (Holiday) tests indicating the steel pipe section has passed the test. The steel pipe section shall be identified by pipeline stationing.

4. All welding procedures used to fabricate pipe shall be qualified under the provision of AWS B2.1 or ASME Section IX. Skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used shall do all welding. Welders shall maintain current qualifications under the provisions of AWS B2.1 or ASME Section IX. Machines and electrodes similar to those in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders.

   a. Visual Inspection of Welded Joints:

      1) The Engineer shall visually check the steel pipe joints prior to welding and during the welding process to detect conditions which may result in a discontinuity in the completed weld.
      2) After the parts are assembled for welding, the Engineer shall check the weld joint for root opening, edge preparation, conformance with the AWWA C206 preheating requirements, and other features which might affect the quality of the weld.

3) During welding, the Engineer shall monitor the root opening as welding of the root pass progresses for assurance of proper joint penetration and alignment, and to detect conditions which may result in a discontinuity in the completed weld.

4) Any defects found during the course of the intermediate inspection shall be repaired by the Contractor without additional compensation.

5) The Contractor shall assist, cooperate and coordinate with the Engineer during the course of the intermediate inspection without additional compensation. This includes providing continuous ventilation at a minimum rate of six (6) air changes per hour while the Engineer is inside the pipe.

b. Final Inspection of Welded Joints:

1) The Contractor shall retain the services of an independent inspection firm to perform final inspection of all welded joints. Welds shall be inspected using one of the nondestructive test methods described In Chapter 15 of the American Welding Society's Welding Handbook, Volume 1, Welding, Technology.

2) It is anticipated that the final inspection will utilize the liquid penetrant, magnetic particle and ultrasonic test methods. At the discretion of the independent inspection firm, radiographic testing may be used if deemed necessary. In addition to being certified under the Welding Engineer Qualification and Certification Program of the American Welding Society, those responsible for final inspection shall submit to the Engineer evidence that they have successfully performed this Work on other large diameter welded steel water transmission mains within the last three years, and are knowledgeable of the nondestructive test methods hereinbefore mentioned.

3) The liquid penetrant test shall conform to the requirements specified in ASTM E 165, under Method B and to the ASME Boiler and Pressure Vessel Code, Section VIII, Appendix B. The materials used shall be either water washable or nonflammable. Chip out all defects, reweld, and retest the section affected until it shows no leaks or other defects.

4) The magnetic particle test shall conform to the requirements specified in ASTM E 709, using the dry powder technique. Chip out all defects, reweld, and retest the section affected until it shows no leaks or other defects.

5) The ultrasonic test shall conform to the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels. Repair defects in the welds disclosed by ultrasonic testing. Prepare a report of the ultrasonic testing and submit to the Engineer for review.

6) Any defects found during the course of the final inspection shall be repaired by the Contractor without additional compensation.

7) The Contractor shall assist, cooperate and coordinate with the Engineer during the course of the final inspection without additional compensation. This includes providing continuous ventilation at a minimum rate of six (6) air changes per hour while the Engineer is inside the pipe.

8) Once the final inspection is complete, the Contractor shall certify to the Engineer that the welded joints are acceptable.

9) The Engineer may elect to perform random nondestructive tests on joint welds.

F. Prestressed concrete pressure pipe (PCCP) and fittings, steel cylinder type, procedures, tests and requirements set forth herein are in addition to, and for the purpose of, monitoring the quality of prestressed concrete pressure pipe supplied under AWWA C301 and AWWA C304. The examinations and tests required shall be performed by the material supplier, pipe manufacturer or laboratory as designated herein, and the results forwarded to the Engineer. Compliance with these requirements shall not otherwise relieve the manufacturer of the responsibility to furnish materials and perform Work in accordance with the requirements of the Specifications. The definitions of terms used shall be those as outlined in the latest edition of AWWA C301 and C304. In addition, the term "supplier" shall mean an organization that manufactures or supplies material incorporated in the pipe.

1.4 TESTS AND EXAMINATIONS

A. General

1. Tests, in-process and final examinations to assure conformance with the Specifications shall be as established herein. Examinations to verify the quality of Work shall be performed by persons other than those engaged in the activity being examined. Such persons shall not report directly to the production supervisor responsible for the Work.
2. The Engineer, or his representative, reserves the right to inspect each section of pipe at various stages of production as indicated below in Paragraph 1.3, E, 3, In Process Examination. Accordingly, the manufacturer shall provide the Engineer with a written production schedule, which facilitates in-process examinations as described herein.
3. Testing shall be performed in accordance with the standard procedures referenced. In the absence of established written procedures, the test methods shall be documented by the manufacturer and proved by actual demonstration, to the satisfaction of the Engineer. At least one (1) copy of the procedures to be followed shall be available to all appropriate personnel at the testing site for reference and use.
4. Materials and items previously checked with equipment and found to be out of calibration or adjustment shall be considered unacceptable until it can be determined that all applicable requirements have been met.
5. The manufacturer shall maintain records of all required tests and inspections. These records shall include documents such as records of materials, manufacturing, examination, repairs, and test data taken before and during fabrication. The Engineer reserves the right to request that specific data be included in a report, which may not otherwise be included. Whenever tests and examinations are performed on a pipe element or pipe, the appropriate identification number shall be shown on the report. Copies of all reports of tests by the manufacturer, independent laboratory or material suppliers shall be given to the Engineer in such forms as to be appropriate for permanent records.
6. The Engineer shall have access to all records of tests and inspections related to pipe manufactured for use in the Contract, and shall also have the right to witness any tests being performed by the manufacturer or his suppliers relative to

products, materials or the pipe being produced. The Contractor shall notify the Engineer sufficiently in advance of pipe manufacturing so that the Engineer has the opportunity to monitor all pipe manufacturing operations.

B. Fabrication Testing and Examination:

1. Testing and examination of the materials used in fabrication of the pipe shall be executed in accordance with the procedure, and at the frequency listed. The required testing shall be done by either the material supplier, independent laboratory, or manufacturer. The test area, wherein the tests are performed, shall be properly certified and the form of such certification shall meet with the Engineer's approval. Testing by the material supplier of independent laboratory shall not relieve the manufacturer of the responsibility to provide materials or follow procedures in accordance with the Specifications. Where the listed frequency of testing differs from that required by the referenced Specification or test method, the greater frequency shall govern.
2. Test frequency shall be on a source basis. The Engineer reserves the right to call for tests during the manufacture of the pipe. The tests shall be applied to each source, and the results approved by the Engineer prior to use. The frequency of tests shall be at least once a week for all materials except as follows:

    a. Daily, Moisture content of aggregates, slurry and mortar proportions and application rates.
    b. Daily, Slump, temperature and unit weight of concrete.

3. Prestressing wire tests—See Section 4.4.8 of the latest edition of AWWA C301

C. In-Process Examination:

1. In-process examination by the Engineer may include, but is not limited to the following at the indicated stages of pipe production:

    a. Cylinder prior to casting concrete

        1) Dents or indentations.
        2) Surface dirt or contamination.
        3) Advanced corrosion. Pits exceeding ten percent (10%) of the sheet shall be a cause for rejection.

    b. Pipe core prior to prestressing: Prestressed Concrete Pressure Pipe

        1) Voids which will not be filled by slurry.
        2) Offsets and bulges which would cause bridging and gaps under the wire.
        3) Damage or cracking in the core concrete.

    c. Prestressed pipe core prior to coating: Prestressed Concrete Pressure Pipe

        1) Adequacy of slurry coverage.
        2) Clearance between prestress wires.

3) Proper position and number of prestress wires.
4) Size of wire.
5) Proper fastening at ends of wire.

2. It is expected that inspection in the above areas applicable to each pipe material shall also be routinely included in the manufacturer's quality control program.

D. Final Inspection: After placement and curing of the concrete, the completed pipe shall be subject to inspection by the manufacturer. This examination shall include but not be limited to:

1. Joint ring dimensions and roundness (manufacturer shall provide templates, if necessary).
2. Cracks, delaminations, unbonded areas, spalls, etc., needing repair: Prestressed Concrete Pipe: PCCP pipe found to have longitudinal cracks from construction equipment or other loading exceeding those allowed by AWWA C304 shall be removed from the line and replaced with sound pipe and closures as required,
3. Marking and identification.
4. For each pipe size provided, periodically pressure test one percent (1%) of each diameter pipeline length for a minimum of twenty (20) minutes. The test pressure shall be one hundred fifty (150) psi. Test caps or plugs shall be attached to the sample pipes using standard rubber gaskets. At the conclusion of the test, there shall be no visible cracks in the mortar coatings, no indication of seepage through the pipe wall, and no visible leakage at pipe joints.
5. Should any of the test pieces fail, the Engineer shall be notified, in writing, of such failure, within twenty-four (24) hours.
6. Once notified, the Engineer may at his option elect to increase the frequency of testing and/or reject any previously manufactured pipe.
7. After shipment to the job site and prior to installation, prestressed concrete pipe will be inspected by the Engineer for cracks, delaminations, spalls or other defects. In addition, the coating will be "sounded" using a ball peen hammer having a head weight of not more than one (1) pound, over its entire exterior surface at the spacing of approximately one foot (1′) both circumferentially and longitudinally to locate any hollow or drummy areas which would indicate a delamination or void.

E. Chlorination and Field Tests

1. The Contractor shall furnish all labor, tools, materials, and equipment necessary to perform the tests specified and to chlorinate the water mains. The cost of testing and chlorination including all materials, labor and equipment shall be included in the unit prices Bid for the waterline.
2. All equipment used in testing shall be provided by the Contractor, and subject to the approval of the Engineer, and shall be such as to properly develop, maintain and measure hydrostatic test pressures and leakage rates. Where devices such as meters, recorders, charts, plugs, caps, blind flanges, corporation stops or bulkheads are required to develop, maintain and measure test pressures, these devices shall be furnished and installed by the Contractor.
3. All defects revealed by the tests shall be corrected without cost to the City. Tests and repairs shall be continued until test requirements are met. Repairs to the various systems shall be made with new materials. When it is necessary to

replace pieces of pipe, the replacement shall be the same material and thickness as the defective piece. Tests shall be repeated after defects disclosed thereby have been made good.

4. The section of water main shall be filled by a metered connection from such existing fire hydrant or main as may be designated by the Engineer. When charging and testing water mains which are not sufficiently close to existing water mains carrying City water to permit connection direct by pipe or hose lines., City approved tank wagons shall be used to haul water and serve as suction tanks.

F. Chlorination, Flushing, and Bacteriological Testing

1. When the water mains are completed, each section shall be chlorinated in accordance with AWWA C601 except as noted below. A solution of hypochlorite of lime or chlorine gas shall be discharged into the water main, by means of continuous feed, near the point where the water main is being charged. This solution shall be of such strength and quantity as may be necessary to provide ten (10) parts per million, by weight of residual chlorine after twenty-four (24) hours, in the section of water main being charged. If the required residual is not obtained, the Contractor shall repeat the chlorination until it obtains this residual.
2. After the twenty-four (24) hour (minimum) disinfection period, the Contractor shall flush the water main until the chlorine level is at or below one (1) ppm.
3. The Engineer shall determine the amount of main to be chlorinated and tested at any one time and reserves the right to separate the installation into several sections in the event of long extensions, or installations of pipe designed for different head conditions or for other reasons.
4. The Engineer will collect water samples in accordance with AWWA C652 and provide for their analysis for bacteriological quality. If the results meet the requirements of the City's Water Quality Lab, and they release the main for active service, then, the water main can then be tied into the distribution system. Should the chlorine residual and bacteriological analysis not be satisfactory, the Contractor shall flush and rechlorinate the water main until satisfactory results are obtained. Samples shall be taken for every street, court or section.
5. It shall be the responsibility of the Contractor to purge the line of the chlorinated water after it has been tested. No detectable chlorine can be released into a stream. Upon successful testing and disinfection of the new water mains, the Contractor shall dispose of the chlorinated water using either of the following two methods. The Contractor must submit a proposed plan for method of disposal of chlorinated disinfection water to the Engineer for approval prior to proceeding.

    a) Discharge directly into an available public sanitary sewer. The discharge point must be approved by the Engineer prior to implementation. The discharge rate must be controlled to avoid overloading of the sanitary sewer. This is the preferred method.
    b) Pump the water main and haul the chlorinated water to a safe discharge location (sanitary sewer).

G. Hydrostatic/Leakage Testing

1. Hydrostatic Testing: Water mains and appurtenances shall be hydrostatically tested by the Contractor in accordance with AWWA C600 and as specified herein.

a. All piping shall be adequately braced and supported during the tests so that no movement, displacement or damage will result from the application of the test pressure. Relief devices in the various systems shall be capped or plugged during the tests. The Contractor shall cap and buttress the new water main between the sections of the existing pipe. Where concrete pipe is installed, the Contractor shall furnish, at his own cost and expense, all necessary bulkheads, caps, plugs or other fittings required to stop off, temporarily, the main by means of sleeves and spacers or other approved methods. Piping systems shall not be tested against any valves. When hydrants are in the test section, the test shall be made against the operating valve in the hydrant. All hydrant branch valves shall be in the open position during this test phase.

b. Ductile iron pipe (DIP), PVC, steel pipe (with gasketed joints) and prestressed concrete pressure pipe (PCCP) shall be hydrostatically tested by slowly filling the main with chlorinated water. The pressure shall be raised to a value as specified on the Contract Drawings. The test pressure shown on the Contract Drawings shall be applied at the low point of the main shall be maintained for at least thirty (30) minutes. Test pressure shall not vary by more than plus or minus five (± 5) psi for the duration of the test. Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air vents are not located at all high points, air shall be bled thru a temporary outlet. In ductile iron pipe corporation cocks shall be installed at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place as required by the Specifications.

c. High density polyethylene (HDPE) pipe shall be hydrostatically tested by slowly filling the main with chlorinated water after the line has adequately anchored by placing initial backfill up to at least six inches (6″) over pipe. The joints and fittings, and particularly flanged connections may be left uncovered for visual leak inspection. Take care to bleed off all trapped air.

d. The HDPE pipe should then be subjected to a hydrostatic pressure test with a test pressure as given in the Contract Documents at the lowest elevation in the system. The test procedure consists of two (2) steps: An initial expansion phase and the test phase. When HDPE pipe is first pressurized, an initial gradual diametric expansion occurs which results in a drop in test pressure that must be compensated by the addition of make-up water. In the first phase of this test procedure, sufficient make-up water is added four (4) times to the system at approximately one (1) hour intervals to return to the test pressure. At the completion of this first phase, approximately four (4) hours after initially pressurizing the pipe under test, the actual test phase then commences. The test phase should not exceed three (3) hours. At the end of the test phase, a measured amount of make-up water is added to return to the test pressure. The amount of make-up water shall not exceed the allowances given in Table A. Under no circumstances shall the total time under test exceed eight (8) hours. If the test is not completed due to leakage, equipment failure, etc., the test section shall be permitted to “relax” for eight (8) hours prior to the next testing sequence.

Table A – Allowance for HDPE Pipe Expansion Under Pressure* for Ambient Conditions

Nominal Pipe Size	Allowance for Expansion U.S. Gallons per 100 ft of Pipe		
Inches	1 hr. Test	2 hr. Test	3 hr. Test
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.00	1.50
10	0.75	1.30	2.10
12	1.10	2.30	3.40
14	1.40	2.80	4.20
16	1.70	3.30	5.00
18	2.20	4.30	6.50
20	2.80	5.50	8.00
22	3.50	7.00	10.50
24	4.50	8.90	13.30
28	5.50	11.10	16.80
32	7.00	14.30	21.50

* Table A Note: These allowances only apply to the test phase and not the initial expansion phase. In addition, they assume that the pipe is being tested for a system design pressure equal to the pipe's pressure class. If the pipe is being tested to a lower system design pressure, the above allowances should be reduced by the ratio of the system design pressure to the pipe's pressure.

e. Should these tests show the main to be defective, the Contractor shall remedy such defects and retest the main as specified above. This procedure shall be repeated until the test requirements are met. The Contractor shall schedule all tests with the Engineer at least forty-eight (48) hours in advance of the test, and all tests shall be conducted to his entire satisfaction.

H. Leakage Testing: After the satisfactory completion of the hydrostatic tests, the new installation of ductile iron, PVC, steel pipe (with gasketed joints) and concrete pipe shall then be subjected to a leakage test at working pressure of at least twenty-four (24) hours duration. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within five (5) psi of the specified test pressure after the pipe has been filled with water and air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time. Until the leakage test requirements are met, the Contractor shall make all repairs that may be necessary to accomplish this. After all tests have been satisfactorily completed, the Contractor shall connect the new water main with the distribution system.

Allowable leakage in ductile iron pipe at various pressures are shown in the following table:

Table B – Allowable leakage for Ductile Iron Pipe per 1000 ft. of pipeline* – gph

Avg. Test Pressure	Nominal Pipe Diameter - in.														
psi	4	6	8	10	12	16	20	24	30	36	42	48	54	60	64
450	0.64	0.95	1.27	1.59	1.91	2.55	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	0.60	0.90	1.20	1.50	1.80	2.40	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	0.56	0.84	1.12	1.40	1.69	2.25	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	0.52	0.76	1.04	1.30	1.56	2.08	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	0.50	0.75	1.00	1.24	1.49	1.99	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	0.47	0.71	0.95	1.19	1.42	1.90	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	0.45	0.68	0.90	1.13	1.35	1.80	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	0.43	0.64	0.85	1.06	1.28	1.70	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	0.40	0.59	0.80	0.99	1.19	1.59	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	0.37	0.55	0.74	0.92	1.10	1.47	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.82

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size. This chart was derived using the formula: $L = (SD(P)^{.5})/113{,}200$, where L = allowable leakage, in gallons per hour S = length of pipe tested, in feet D = nominal diameter of pipe, in inches P = average test pressure during the leakage test, in pounds per square inch (gauge).

1. Allowable leakage in polyvinyl chloride (PVC) pipe at various pressures are shown in the following Table:

Table C – Allowable leakage for PVC Plastic Pipe with Elasometeric Joints per 1000 ft. of pipeline or 50 Joints* – gph

Nominal Pipe Size	Average Test Pressure in Line – P.S.I.		
Inches	150	200	250
4	0.33	0.38	0.43
6	0.50	0.57	0.64
8	0.66	0.76	0.85
10	0.83	0.96	1.07
12	0.99	1.15	1.28

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size. This chart was derived using the formula: $L = (ND(P)^{.5})/7400$, where L = allowable leakage, in gallons per hour N = number of joints in line tested, D = nominal diameter of pipe, in inches P = average test pressure during the leakage test, in pounds per square inch (gauge)

I. High density polyethylene

(HDPE) pipe testing for leakage can be done by maintaining the HDPE pipe working pressure over a period of four (4) hours using the same two phase procedure described for the hydrostatic test, and then dropping the pressure by ten (10) psi. If the pressure remains steady (i.e., within five percent (5%) of the target value) for an hour, this indicates that there is no leakage in the system. Under no circumstances shall the total time under test exceed eight (8) hours. If the test is not completed due to leakage, equipment failure, etc., the test section shall be permitted to "relax" for eight (8) hours prior to the next testing sequence.

J. Continuity Testing for PVC and HDPE Pipe

After backfilling, the Contractor shall test the tracer wire to demonstrate electrical continuity between fire hydrants or any other type of testing appurtenances and through the length of the PVC or HDPE pipeline installed. Any discontinuity shall be located, repaired, and retested at the Contractor's expense until continuity is achieved.

1.5 SUBMITTALS

A. Shop drawings shall be submitted as specified in 01 33 23 (Shop Drawings, Product Data, and Samples) for the following materials, and shall include the following information:

1. Ductile iron pipe (DIP) and fittings: product information and dimensions; pressure rating or class; storage, handling, and installation recommendations.
2. Polyvinyl chloride (PVC) pipe and couplings: product information and dimensions; pressure rating; storage, handling, and installation recommendations for pipe, joint restraint devices, pipe couplings, wire connector splice kits, service saddles, and manufacturer's instructions for tapping pipe.
3. High density polyethylene (HDPE) Pipe and Fittings: product information and dimensions; pressure rating; storage, handling, and installation recommendations for pipe, fittings, joint restraint devices, wire connector splice kits, service saddles, and manufacturer's instructions for tapping pipe.

B. Steel Pipe:

1. Product information and dimensions; pressure rating or class; storage, handling, and installation recommendations.
2. Lay schedule of new pipe and fittings indicating alignment and grade, laying dimensions, lining and coating systems, proposed welding procedures, fabrication, fitting, flange and special details. Show station numbers for pipe and fittings corresponding to Drawings.
3. Shop Drawings:

    a. Shop drawings showing dimensions and details of pipe, joint fittings, fitting specials, valves and appurtenances.
    b. Joint and fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; manufacturing tolerances; and all other pertinent information required for the manufacture of the product.
    c. Joint details shall be submitted where deep bell or butt strap joints are required for control of temperature stresses. Fittings and specials details such as elbows, reducers, wyes, tees, crosses, outlets, connections and test bulkheads, and nozzles or other specials where shown which indicate amount and position of all reinforcement. All fittings and specials shall be properly reinforced to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions as indicated in the Contract Documents.
    d. Material lists and steel reinforcement schedules which include and describe all materials to be utilized.
    e. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds.
    f. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them.

C. Prestressed concrete pressure pipe (PCCP) and fittings:

1. Shop drawing submittals shall include certification that the pipe, fittings, and appurtenances are in conformance with the applicable standards and design criteria as specified herein, and include details of special fittings, joint and gasket dimensions.
2. A laying schedule which references stationing and elevations as shown on the drawings for all piping systems along with the manufacturer's drawings indicating details of all items shall be submitted for approval. The laying schedule shall show code numbers for all pipe, fittings, and specials. These code numbers shall correspond to markings on the pipe, fitting, or special. The above shall be submitted to the Engineer for review before manufacture and shipment. The locations of all pipes shall conform to the locations indicated on the drawings. The laying schedule shall indicate pipe joint lengths. The laying schedules shall include the locations and lengths of all restrained joint pipe and fittings, and the layout for all deflected pipes. Also indicated on the lay schedule shall be the joint deflection for pipe installed on curved alignment. To accommodate alignment and layout

pipe less than manufacturer's standard full length may be required. The use of beveled or half beveled pipe joints may be required.

a. The manufacturer shall submit concrete and mortar mix designs for the permanent records of the Engineer, prior to fabrication of pipe

b. Restraints, retainer glands, and associated hardware: product information and dimensions; pressure rating; installation recommendations. Details of all welding and welder qualifications shall be furnished to the Engineer in such form as, to be appropriate for permanent record. Provide welder qualifications in accordance with AWWA C206

c. A packing list or invoice shall accompany every shipment and shall contain the following information; City contract number, kind and class of pipe, length and other pertinent information.

d. Installation and Repair Recommendations:

1) Submit manufacturer's recommended installation procedures for pipe, and structures.

2) Submit recommended repair methods and procedures for defects and damage to pipe from manufacturer furnishing product. Repairs shall be performed by the manufacturer using specifically trained personnel and shall proceed only after approval of the Engineer and in his presence.

e. The manufacturer's control number or work order number pertaining to any given section of pipe shall be stamped on the spigot joint ring when production has begun and legibly and indelibly marked on the concrete interior of the pipe following curing. All inspection reports and production records shall show the work control number.

D. Certificates of Compliance

1. The manufacturer shall provide an affidavit certifying that the underground pipe, fittings, and appurtenances comply with the standards cited in the piping and fitting schedules. Submit certificates of compliance before delivery of materials in accordance with 01 33 00 (Submittal Procedures) for pipe and fittings furnished by the Contractor under this Section. Certificates shall include City Contract Number, job location, Contractor's name, types, classes and strengths of pipe, dimension ratio (for PVC pipe), manufacturer's identification codes for nominal size, production record code, date of manufacture and pipe manufacturer's name. Certificates of compliance for concrete materials are specified in 03 30 00 (Portland Cement Concrete Structures).

2. The certificates of compliance for the following materials shall state that the item supplied is in accordance with the requirements specified herein:

a. Ductile iron pipe (DIP) and fittings, joint restraint devices, and pipe couplings.

b. Polyvinyl chloride (PVC) pipe, joint restraint devices, pipe couplings, tracer wire, wire connector splice kits, detection tape, and service saddles.

c. High density polyethylene (HDPE) pipe, fittings, joint restraint devices, tracer wire, wire connector splice kits, detection tape, and service saddles. The Manufacturer shall supply certification that the materials used to

manufacture the pipe and fittings have standard grade HDB rating of sixteen hundred (1600) psi. (minimum) at seventy-three degrees (73°) F. The manufacturer shall certify that all materials used to manufacture the pipe and fittings have been evaluated, tested and certified for conformance with ANSI/NSF Standard 61.

d. Steel pipe:

1) The Contractor shall furnish a certification stating that all pipe special fittings, and other products or materials furnished under this Section of the Specifications comply with AWWA C200 and C205.
2) Submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section.
3). Submit a certification that the discontinuity (Holiday) tests indicating the steel pipe section has passed the test in accordance with Paragraph 1.3,E,3. The steel pipe section shall be identified by pipeline stationing.

e. Prestressed concrete pipe (PCCP), fittings, joint restraint devices, pipe couplings, detection tape, and service saddles.

E. Certified Test Results

1. Submit certified test results before delivery of materials in accordance with 01 33 00 (Submittal Procedures) for pipe and fittings furnished by the Contractor under this Section. Certificates shall include City Contract Number, job location, Contractor's name, types, classes and strengths of pipe and pipe manufacturer's name. Certified test results shall be submitted for the following:

a. Furnish certified reports of the following tests for steel pipe:

1) Physical and chemical properties of all steel.
2) Hydrostatic test reports.
3) Results of production weld tests.
4) Upon request by the City, mill test reports on each sheet from which steel is rolled will be submitted.

b. Ductile iron pipe (DIP) and fittings
c. Polyvinyl chloride (PVC) pipe: Submit manufacturer's written transcript of test results, for sustained pressure, pipe dimension, burst pressure, flattening resistance, and extrusion quality test. Frequency of performing the tests and the methods of selecting test specimens shall be in accordance with AWWA C900.
d. High density polyethylene (HDPE) pipe and fittings.
e. Prestressed concrete pipe (PCCP) and fittings:

1) The manufacturer shall provide copies of all written quality control procedures, tests and reports as may be employed by the manufacturer during the production of the pipe. Such information shall be kept confidential when so requested by the manufacturer.
2) Prior to approval of the finished pipe, the manufacturer shall submit for the Engineer's record, Certified Material Test Reports for the

following materials: aggregates; cement admixtures; wire fabric; reinforcing rod; steel sheet, coils, plats, bars, castings and shapes; joint rings; bolts; jugs and gaskets.

3) Water for mortar and concrete mix shall be certified to have met the requirements of ASTM C94. Certified Reports shall show the actual results of all required chemical analyses, physical tests, examinations and heat treatments, including times and temperatures.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland cement concrete for pipe fitting buttresses and anchorages shall be Mix No. 1 for unreinforced concrete buttresses and Mix No. 3 for reinforced concrete buttresses. Concrete mixes shall be as specified in 03 30 00 (Portland Cement Concrete Structures)

B. Polyvinyl chloride (PVC) pipe

1. Pipe

a. PVC pipe four inches (4″) through twelve inches (12″) in diameter shall be manufactured in twenty foot (20′) lengths in accordance with AWWA C900 with cast/ductile iron pipe equivalent outside diameters.

b. Pipe shall have a dimension ratio (DR) of eighteen (18), pressure class of one hundred sixty (160) psi, and shall utilize elastomeric gasketed push-on joints for joining pipes in accordance with AWWA C900.

c. Pipe, gaskets, and gasket lubricant shall be suitable for potable water systems and shall meet NSF 61.

d. All PVC pipe shall be factory marked on the spigot end for depth of insertion into the bell and factory tested in accordance with AWWA C900.

2. Fittings for use with PVC water mains shall be ductile iron in accordance with Paragraph 2.1, C, 3. PVC fittings, if approved by the Engineer, must be molded. No fabricated fittings will be allowed.

3. Couplings

Pipe couplings for PVC water mains shall be suitable for potable water service and shall have epoxy or nylon coated ductile iron center and end rings.

4. Joint Restraint

a. Horizontal and vertical bends, tees, caps and fittings shall be buttressed or anchored in accordance with the Plans, Paragraph 2.1, C, 5, c and Details for Construction, or as directed by the Engineer. Valves, when connected to PVC pipe, shall be iron body resilient seat gate valves and anchored in accordance with the detail shown on the Plans and shall have one (1) full length of pipe on each side of the valve.

b. Joint restraints for harnessing joints shall be in accordance with the Paragraph 2.1, C, 5 and the requirements below:

1) All joint restraint devices shall be Underwriter Laboratory (UL) approved.
2) PVC pipe shall not be deflected. If deflection is required in a restrained joint, use ductile iron pipe or fittings.
3) Where a restrained joint is required between PVC pipe and a fitting, the fitting shall be ductile iron mechanical joint. Joint restraint for this joint shall meet ASTM F1674. Contact Water and Waste Water Engineering Division for the approved list of manufacturers.
4) Where a restrained joint is required for PVC push-on joint, joint restraint shall be preapproved Contact Water and Waste Water Engineering Division.

5. Connections

a. Connections to PVC waterlines shall be by using fittings, such as tees, indicated on the Plans.
b. Saddles are required for two inch (2″) and smaller connections to PVC waterlines. Saddles with clamps shall provide full support around the circumference of the pipe and shall not distort, scratch, or damage the pipe when tightened. Only tapping saddles manufactured specifically for AWWA C900 PVC pipe shall be used. Saddle and clamps/straps shall be formed to meet the curvature of the pipe. Saddles with clamps shall be manufactured for underground service, shall be rated for a minimum service of 150 psi and shall be brass or bronze alloy meeting ASTM B62 or B584 and AWWA C800 or ductile iron saddles meeting ASTM A536 or A395 with two (2), 18-8 stainless steel straps and shall be epoxy or nylon coated. Saddles shall have watertight gaskets of Fuma-N rubber meeting ASTM D2000 or nitrile around the tap hole.

C. Ductile Iron Pipe and Fittings

1. Pipe

a. Pipe shall be manufactured in accordance with the requirements of AWWA C151 except that the metal thickness shall be as described herein. Pipe nominal lengths may be eighteen to twenty feet (18′ to 20′) and shall include all jointing materials.
b. All pipe and fittings shall be designed and constructed to withstand all external pressure caused by overburden as indicated on the profile and traffic loads to which the pipe may be subjected.
c. All ductile iron pipe shall be Class 54. All ductile iron pipes will be designed for a Type 1 laying condition, unless otherwise specified in the Contract Documents.
d. Unless otherwise specified, outside diameter of ductile iron plain end shall be the same as for mechanical joint cast or ductile iron pipe.

2. Joints

a. Joints may be mechanical, flanged or rubber gasketed push-on type. Unless otherwise noted, all joints shall be in accordance with AWWA C111.

Provide all joint accessories, as required, to connect with plain end of push-on joint pipe or cut pipe.

b. Flanged joints shall meet requirements of AWWA C115 and as supplemental herein. Flange bolts, nuts and washer shall be carbon steel ASTM A307, Grade B with good, sound, well fitting threads. Nuts shall be cold punched, hexagonal, trimmed and chamfered. Heads, nuts and threads shall be ANSI B1.1. Bolts shall have one quarter-inch (1/4″) project beyond the nut when the joint with gasket is assembled. Gaskets shall be full faced, one-eighth inch (1/8″) thick rubber. No flanged joints should be direct buried.

3. Fittings

a. Fittings forty-eight inches (48″) and smaller diameter shall be mechanical joint bell, ductile iron in accordance with AWWA C153 for compact fittings sizes four inches to sixteen inches (4″ to 16″), including dimensions and weights.

b. Fittings fifty-four inches (54″) and larger diameter shall be push-on bell, ductile iron, proprietary restrained joints in accordance with AWWA C153.

c. Fittings shall be designed and constructed to withstand a pressure not less than as specified in AWWA C 153 or for the adjacent pipe, whichever is greater.

d. Provide exterior asphaltic coating per AWWA C-110 and interior double thickness cement mortar lining and seal coated inside in accordance with per AWWA C-104; or provide interior and exterior fusion bonded epoxy coating, six to eight (6–8) mil in thickness, conforming to AWWA C116.

e. The cast markings required in AWWA C153, clearly mark on each fitting the year, month and date cast, and number of lot.

f. The gasket dimensions shall conform to the dimensions and tolerances per AWWA C111 Section 11-8, or with special designs and/or shapes shall meet the performance requirements of AWWA C111 Section 11-10. The size, mold number, gasket manufacturer's mark, manufacturer's country, the letters MJ and the year of manufacture shall be molded or permanently marked on the gasket. The molded markings shall not be on the sealing surface.

g. When flange fittings or connecting pieces are required, they shall meet requirements of AWWA C153. Flanges shall be cast integrally with body and shall have the same thickness over their entire circumference. Faces shall be perpendicular to axis of pipe. Bolt holes shall be equally spaced and shall straddle the centerline of the fitting. Provide all joint accessories required.

h. All fittings shall be complete with all joint accessories, rubber gaskets, bolts and nuts.

4. Lining and Coating

All pipe and fittings shall be cement lined in accordance with AWWA C104, double thickness. This lining shall be sealed with a bituminous seal coat. The outside surface shall be bituminous coated per AWWA C151. All buried metal pipe and/or appurtenance that do not have factory applied protective coating or whose coatings have been damaged shall receive one (1) prime coat and one (1) finish coat of field applied coating system applied in accordance with AWWA C210. Field coatings shall be complete prior to line tests

5. Joint Restraint

a. Restrained joint pipe and fittings shall be of the pipe manufacturer's standard design for ductile iron, and steel pipe and fittings. Unless otherwise noted, pressure ratings for pipe harnessing components shall not be less than the pipe working pressures. All rubber gasketed push-on type restrained joints should only be provided by manufacturer or suppliers who are authorized and licensed by the manufacture and they should be designed applied handled and installed in strict accordance with DIPRA and the pipe manufacturer's recommendations. Push-on joint ductile iron pipe with proprietary restraint shall be as follows:

1) For pipe thirty-six inches (36″) and smaller in diameter: Contact Water and Waste Water Engineering Division for the approved list of manufacturers.
2) For pipe forty-two inches (42″) and larger diameter: Contact Water and Waste Water Engineering Division for the approved list of manufacturers.

b. Retainer glands for restraint of mechanical joint, ductile iron pipe twenty-four inches (24″) and smaller diameter shall be designed to fit standard mechanical joint bells conforming to AWWA C111. Glands shall be manufactured of ductile iron conforming to ASTM A536 with a restraining mechanism of size and arrangement per manufacturer's recommendations, of the following type:

1) Ductile iron wedges in combination with special, heat treated set screws with or without twist off nuts, torqued per manufacturer's recommendation; or
2) Hardened steel set screws with knurled and cupped points, with or without twist off nuts.
3) Retainer glands shall, at a minimum, meet the working pressure ratings for the pipe.
4) Contact Water and Waste Water Engineering Division for the approved list of manufacturers.

c. Rod for tie rod assemblies shall meet the material requirements of ASTM A 193, Grade B7, and shall be threaded for at least eight inches (8″) on both ends. Rod shall be three-quarters of an inch (3/4″) diameter unless otherwise noted. Nuts shall meet the requirements of ASTM A 194. Manufactured tie rod and accessories shall result in the completed restrained joint assembly having a minimum working pressure rating of two hundred (200) psi. Steel for strapping and harnessed joints shall be minimum three-quarters of an inch (3/4″) diameter and meet requirements of ASTM A588 and A307. All nuts and bolts and harness tie rods shall be steel, zinc plated with an epoxy or nylon coating, or ANSI 304 Grade Stainless Steel. T bolts, harness tie rods, coupling bolts, flanged joint bolts, etc. shall be designed to provide at least one (1) complete thread projecting beyond the nut when properly tightened. Any such threaded unit that fails to meet this requirement shall be replaced at no additional cost to the City.

D. High Density Polyethylene Pressure Pipe (HDPE)

1. Pipe

a. High Density Polyethylene Pressure Pipe and Fittings sizes four inches (4″) inch through thirty inches (30″) shall conform to AWWA Specification C-906, latest revisions. The pipe and fittings shall be made of Extra High Molecular Weight (EHMW) high density polyethylene with a standard thermoplastic material designation code of PE3408 and having a cell classification of 345464C per ASTM D3350.

b. All HDPE water pipe shall be manufactured with three (3) equally spaced pairs of blue stripes.

c. Materials used to manufacture pipe and fittings shall be listed under the Manufacturer's name in the Plastics Pipe Institute (PPI) TR-4, "PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Materials or Pipe." The Manufacturer shall supply a product with a standard grade HDB rating of sixteen hundred (1600) psi (minimum) at seventy-three degrees (73°) F.

d. All HDPE pipe shall be of pressure rated DIPS DR 11- rated at one hundred sixty (160) psi.

e. Minimum pipe wall thickness shall be SDR 13.5 for pipe six inches (6″) through thirty inches (30″) in diameter and SDR 11 for pipe three inches (3″) in diameter.

2. Fittings

a. High density polyethylene fabricated fittings shall be manufactured from high density polyethylene pipe, sheet stock or molded fittings meeting the material and pressure rating requirements of this Specification and all appropriate requirements of AWWA C-906. The fittings shall be HDPE, in accordance with ASTM D 3261. The fittings shall be manufactured from the same base resin type and cell classification as the pipe itself.

b. Polyethylene Fittings All PE fittings shall be SDR 11 for pipe six inches (6″) through thirty inches (30″) in diameter. SDR 9 shall be used for three inch (3″) pipe diameter fittings. All PE fittings shall have a blue shell, a minimum of six (6) longitudinal blue stripes, the AWWA Specification stamp embedment or permanent blue-line print.

3. Service Connections/Leads (Made from HDPE)

a. Services leads below four inches (4″) in diameter shall be transitioned to copper at the saddle fitting/corporation, and service leads four inches (4″) and above in diameter shall be HDPE with below mentioned flanged adapters at meter location.

1) Service Tapping Saddles (Electrofusion): Service tapping saddles three-quarters of an inch (3/4″) to two inches (2″) may be made with electrofusion fittings as manufactured in accordance with ASTM Specifications F-1055 for use with pipe conforming to ASTM F-714. Electrofusion fittings shall be supplied and tested in accordance with AWWA C-906 and NSF Standard 61.

2) Flanged Adapters: All service leads four inches (4") and above shall be provided with High Density Polyethylene Flange Adapters. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves (serrations) to provide gasketless sealing.

E. Prestressed concrete pipe

1. Pipe

a. Except, as herein modified, deleted, or supplemented, prestressed concrete pressure pipe and fittings, steel cylinder type, shall be in accordance with the requirements of the latest editions of AWWA C301 and C304.

b. Design Conditions Pipe shall be designed in accordance with the AWWA C304 Standard, using the following design conditions; these conditions shall also be used in designing fittings.

1) External Loading

a) Earth cover as shown on the Contract Drawings, all in accordance with the AWWA Standard C304. Earth loads shall be computed assuming the trench width that gives the maximum load on the pipe (transition width) for unit soil weight of one hundred twenty (120) pounds per cubic foot, Type R-3 Bedding and embankment conditions in accordance with AWWA M-9 (unless otherwise specified in the Contract Documents).

b) Live loads shall be AASHTO HS-25 and/or AREA Cooper E-80.

2) Test Pressure: Test pressure shall be one hundred fifty percent (150%) of the working pressure with a minimum one hundred fifty (150) psi. Contact City's Water Engineering Office for Design Pressure.

c. The date of manufacture or a serial number traceable to the date of manufacture and the design strength classification shall be clearly marked by stencil with waterproof paint at the end of the pipe barrel. Unsatisfactory or damaged pipe will be permanently rejected, repaired in the field if permitted by the Engineer, or returned for minor repairs. Pits, blisters, rough spots, minor concrete or mortar breakage, and other imperfections may be repaired unless prohibited by the Engineer. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of three thousand (3,000) psi at the end of seven (7) days and forty-five hundred (4,500) psi at the end of twenty-eight (28) days, when tested in cylinders stored in the standard manner. Major breakage or spalling from interior of pipe may be reason for the rejection of pipe. Pipe may be repaired under unloaded conditions (removal of prestressing wire). Cement mortar used for repair shall have a minimum compressive strength of three thousand (3,000) psi at seven (7) days and four thousand five hundred (4,500) psi at twenty-eight (28) days

when tested as standard cylinders. New prestressing wire may be applied when the compressive strength as determined by cylinder testing equals or exceeds the strength required for prestressing as stated in AWWA C301.

d. Cement used for the core, slurry, mortar coating and authorized repairs shall be Type II and shall be in accordance with ASTM C150. If water reducer or a set controlling admixture is to be used in the concrete or cement mortar, it shall be in accordance with section 2.6 of AWWA C301. The information, provided by the manufacturer, must be submitted for approval to the Engineer, regarding the type and amount of any admixtures used in the concrete or cement mortar to produce the quality and strength of the concrete necessary to manufacture the pipe. This policy shall be required whenever any water reducing or set controlling admixtures are used, whether they have been specified in the Contract Documents or not.

e. The pipe core shall be manufactured by the centrifugal method or the vertical casting method.

f. Wire shall be a minimum of No. 6 gauge and shall meet the requirements of ASTM A648, Class III. Wire of a class strength greater than Class III will not be permitted. Steel shorting straps shall be placed beneath prestressing wire for embedded cylinder pipe. T he shorting straps shall be welded to four inch (4″) wide steel bonding clips.

g. Steel cylinders shall be No. 16 gauge minimum and shall be hot rolled.

h. Mortar coating shall consist of one (1) part cement to a maximum of three (3) parts fine aggregate by weight. Rebound material shall not be reused and must be discarded. The slurry application method shall be such that a complete coating of the prestress wire is obtained.

i. Alignment for long radius, curved sections as specified on the Drawings may be produced by joint deflections of standard joints not to exceed that recommended by the manufacturer. Deflections required which are in excess of those recommendations shall be produced by beveling the spigot ends of the pipe.

2. Fittings

a. Steel thickness of all fittings shall be designed in accordance with Chapter 8 of the AWWA M9 Manual. Fittings shall be designed for the same conditions as the adjacent pipe.

b. Fabrication of the fittings shall be as per AWWA M9 Manual and C301.

c. Interior and exterior concrete/mortar coating shall be as per AWWA C301.

d. Bell and spigot wall fittings shall be manufacturer''s standard design. Wall fittings shall be supplied with adequate bracing to keep them round and true during transportation and installation.

3. Joints, Adapters, and Outlets

a. Flanged joint prestressed concrete cylinder pipe and fittings shall be in accordance with the latest edition of AWWA C207. Flanged joints shall be drilled and faced for Class 125 in accordance with ANSI B16. I.

b. Harnessed (spigot and bell end) by flanged PCCP adapters shall be used to modify the existing PCCP, where flanged valves are to be installed. New harnessed adapters, clamps and gaskets shall be compatible with the existing PCCP.

c. Closures shall be "following ring closures" and shall be used to close the connection between the new prestressed concrete cylinder pipe with the existing prestressed concrete cylinder pipe. Closures shall be designed for the same design pressure as the adjacent pipe (minimum pressure of 100 psi).

d. Gaskets for flanged joints shall be full faced. The rubber gaskets shall be in accordance with AWWA C301 and shall be designed and manufactured so that the completed joint will withstand an internal water pressure in excess of the highest pressure to which the pipe will be subjected without showing any leakage by the gasket or displacement of it.

e. Bell and spigot joint rings shall be steel, self-centering type, and otherwise specified in AWWA C301 with rubber gasketed type joints. Surfaces of the joint rings that will be exposed after fabrication is complete shall receive a zinc metalized coating of four (4) mil thickness (0.004″). Unrestrained joints shall be either deep, half bevel, or full bevel. In areas of the alignment where the pipe will be subject to unbalanced hydrostatic thrust forces (bends, tees, bulkheads, wyes, and valves), the pipe joints shall be mechanically restrained (harnessed).

f. The maximum longitudinal stress in the steel cylinder of harnessed pipe sections shall not exceed thirteen thousand five hundred (13,500) pounds per square inch when subjected to the internal working pressure or seventeen thousand (17,000) pounds per square inch when subjected to the test pressure and shall be based on the deflection angle as described in the AWWA M9 Manual. The steel cylinder thickness in pipe sections between the location of the maximum thrust force and the end of the harnessed section can be prorated on the basis of zero (0) longitudinal thrust at the end of the harnessed section.

g. Two (2) acceptable types of harnessed or restrained joints are the harness clamp and split steel ring types of flexible restrained joints.

    1) The clamp type consists of two (2) semicircular steel clamps, which fit over steel lugs that are factory welded or rolled into the steel bell and spigot sections. The semicircular clamps are drawn together by bolts at the springline on both sides of the pipe to form a flexible restrained joint.
    2) The split steel ring type of flexible restrained joint consists of a split steel ring which is recessed in the special steel bell section of the pipe until the joint is made. Once the joint is made, the split steel ring is drawn down into position to form a lock between the bell and spigot by tightening a single steel bolt.
    3) Both joint types shall be capable of transmitting the longitudinal thrust forces due to working pressure and test pressure and must be encased in grout after the joint has been completed and before the line is pressurized using special grout bands supplied by the pipe manufacturer.
    4) Field welding of the joints for restraint during initial installation will not be allowed except where connecting to existing pipe or where follower ring closure assemblies are installed into restrained joint areas unless otherwise permitted by the Engineer.

4. Bolts and Nuts shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M for bolts, and ASTM Al94, Grade 2H for nuts.

5. Coatings

   a. Outside Surface Coating: The outside surface of all below grade prestressed concrete cylinder pipe and fittings shall be coal tar epoxy coated in accordance with the latest edition of AWWA C210. The coating applied shall be preapproved by the Water and Waste Water Engineering Division.
   b. Inside Surface Coating: Interior concrete/mortar coating shall be as per AWWA C301.

6. Bonded Joints: All pipe and fittings shall have bonded joints in accordance with 33 00 02 (Corrosion Control). All Prestressed Concrete Pressure Pipe shall have two (2) bonding clips shall be welded to each joint ring a minimum of twelve inches (12″) apart.
7. Specials: Where required or shown, the Contractor shall provide PCCP specials. Specials shall in general consist of closures, less than standard lengths of pipe, or combination of ends, and nonstandard fittings. The specials shall conform in material, thickness and finish to the pipe in which they are installed.

F. Steel Pipe

1. Pipe

   a. Mortar lined steel pipe shall conform to AWWA C200 and C205, subject to the following supplemental requirements.

      1) The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets or welded joints, as indicated in the Contract Documents, and all specials and bends shall be provided as required for a complete piping system. Steel plate used in the manufacture and fabrication of steel pipe shall meet the requirements of ASTM A1011 or A1018.
      2) Provide steel pipe and encasement sleeves designed and manufactured in conformance with AWWA C 200 and AWWA M 11 except as modified herein.
      3) The steel sheets shall conform to ASTM A570, Grade 45, plates conforming to ASTM A572, Grade 42 or coil conforming to the requirements of ASTM A139, Grade C or D. All welded seams, whether straight or spiral, shall be but welded using an approved electric fusion weld process. Design stress shall be limited to 50 percent (50%) of the yield point stress.
      4) Pipe shall be designed for the working pressure indicated on the Plans with an additional allowance for surge as indicated on the Plans. Pipe design shall be in accordance with AWWA M11 except as mentioned herein.
      5) Pipe shall be bedded and backfilled per the Plan details or manufacturer's recommendations utilizing an E′ value for design, per AWWA M11 Chapter 6 and 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill).

6) Pipe is to be furnished principally in uniform net laying lengths no less than sixteen (16′) feet with shorter lengths, field trim pieces and closure pieces as required by Plan and profile for location of elbows, tees, reducers and other in-line fittings or as required for construction.

7) The pipe fabricator shall prepare a pipe laying schedule showing the location of each piece by mark number with station and invert elevation at each bell end. Provide pipe sections in lengths of no less than sixteen feet (16′) except as required for special sections. Provide short sections of steel pipe no less than four feet (4′) in length unless indicated on Drawing or specifically permitted by Project Manager.

8) Specials are defined as fittings, closure pieces, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials, wherever located, and all piping above ground or in structures.

9) Dimensions of fabricated steel pipe fittings shall comply with AWWA C208.

10) Pipe twenty-four inches (24″) in diameter and larger, the inside diameter after lining shall not be less than the nominal diameter specified or shown. Smaller diameter pipe maybe used with the approval of the Engineer.

11) The Contractor shall be fully liable for the cost of replacement or repair of pipe and specials which are damaged.

12) The Contractor shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation.

13) All special pipe sections and fittings shall be marked at each end indicating the top. The word "top" shall be painted or marked on the outside top spigot end of each pipe section.

b. Cylinder Thickness for Internal Pressure:

1) For resistance to internal pressure, the thickness of the steel cylinder shall not be less than the values given in the following Table

Pipe OD (D) – Inches	Wall Thickness – Inches (t)
24	0.1471
30	0.1814
36	0.2157
42	0.250
48	0.2842
54	0.3186
60	0.3529
66	0.3871
72	0.4214
80	0.4671
84	0.490
96	0.5586

c) Upon determination of cylinder thickness, for internal pressure, deflection of the pipe shall be checked by the following formula:

$$Defl_x = \frac{DKWr^3}{EI + 0.0614\,E'r^3}$$

Where: $Defl_x$ = Vertical deflection of pipe in inches, not to exceed 0.015 times the nominal diameter.

D = Deflection lag factor (1.0–1.5)
K = Bedding constant (0.1)
W = Vertical load on pipe, lb/in (see Notes 1 and 2)
r = Mean radius of pipe shell, inches
EI = Pipe wall stiffness, lb-in (see Note 3)
E' = Modulus of soil reaction, lb/in^2 (based on geotechniclal report recommendations, otherwise refer to Table 6-1 of AWWA M-11).

Note 1 In the determination of the vertical load on the pipe, W, the trench condition shall normally apply unless an actual embankment condition exists or the trench width exceeds the transition width, in which case the embankment condition shall apply. For depths of cover of less than 8 feet (8′), yard piping shall always be designed for an embankment condition. The Contractor is cautioned that depth of covers less than three feet (3′), if permitted, shall be investigated for concentrated wheel loads.

Note 2 For depths of cover of ten feet (10′) or greater, the earth load shall be computed assuming the trench/embankment condition as applicable. For depths of cover of less than the pipe diameter 10 feet (10′), HS-25 live load shall be included. For depths of cover of three feet (3′) or less, HS-25 live load plus impact shall be included.

Note 3 Value of EI is based on the sum of the pipe wall stiffness, mortar lining and coating, and steel cylinder, assuming that it acts as a three (3) part laminar ring which considers no bond between the steel cylinder and the applied lining and coating. The term “pipe wall stiffness” as used herein is defined as EI, where “E” is the modulus of elasticity (E = 30,000,000 psi for steel and E = 4,000,000 psi for mortar) and “I” is the transverse moment of inertia per unit length of pipe wall, the factors in the forgoing expression to be dimensionally compatible.

c. Trench Condition:

$$W_c = C_d w B_d^2 (B_c/B_d)$$

Where: W_c = Earth load, lb/ft
C_d = Load coefficient based on H_c/B_d where H_c is the height of fill above the pipe and B_d is defined below
w = Unit weight of fill, lb/cu ft 120 lb/ft3
B_d = Trench width at top of pipe, feet
B_c = Diameter of pipe, feet

d. Positive Projecting Embankment Condition:

$W_c = C_c w B_c^2$

Where: W_c = Earth load, lb/ft
C_c = Load coefficient, for flexible pipe, the settlement ratio[2] may be assumed to be zero, in which case $C_c = (H_c/B_c)$
H_c = the height of fill above the pipe
w = Unit weight of fill, lbs/cf shall not be less than 120 lb/ft^3
B_c = Diameter of pipe.

e. If the calculated deflection, $Defl_x$, exceeds 0.015 times the nominal diameter, the composite pipe section shall be thickened or the quality of pipe zone backfill shall be improved to achieve a higher soil modulus.

e. Joints

1) The standard field joint for steel pipe shall be either a single welded lap joint or a rolled groove rubber gasket joint for all pipe sizes. Double welded joints with air taps for air pressure testing shall be provided where shown.
2) Butt strap joints shall be used only where required for closures or where shown, or approved by the City.
3) The joints furnished shall have the same or higher pressure rating as the abutting pipe.
4) Lap Weld

a) Lap weld joints shall conform to AWWA C200 and as shown in Chapter 8 of AWWA M11.
b) Lap field welded joints shall be used where restrained joints are required or indicated on the Plans. The standard bell shall provide for a two and one-half inch (2-1/2″) lap. The minimum lap shall be one inch (1″). The maximum joint deflection or offset shall be a one inch (1″) joint pull.
c) Lap welded joints shall be welded either externally or internally. Holdbacks for coating and linings shall be provided as shown on the approved shop drawings. "Weld after backfill" of interior welds may be performed any time after joint completion and backfilling has been completed.
d) For field welded joints, design stresses shall not exceed fifty percent (50%) of the indicated minimum yield strength of the grade of steel utilized, or twenty-one thousand (21,000) psi, whichever is less, for the part being examined when longitudinal thrust is assumed to be uniformly distributed around the circumference of the joint. At the Contractor's option, the steel cylinder area may be progressively reduced from the point of maximum thrust to the end of the restrained length.
e) Unless otherwise shown on the Plans, all field joints shall be lap welded for diameters seventy-eight inches (78″) and greater.

f. Mechanical Couplings

a. Mechanical couplings where indicated on the Plans shall be Smith Blair Style 411, Baker Style 200, Victaulic Depend-O-Loc or equal.
b. Insulating mechanical couplings where indicated on the Plans shall be double insulated Smith Blair Style 416, Baker Style 216, or equal for working pressures up to one hundred fifty (150) psi only.
c. Couplings for buried service shall have all metal parts painted with epoxy paint and conform to AWWA C210.
d. Pipe ends for mechanical couplings shall conform to AWWA C200 and M11. The shop applied outside coating shall be held back as required for field assembly of the mechanical coupling or to the harness lugs or rings. Harness lugs or rings and pipe ends shall be painted with one (1) shop coat of epoxy conforming to AWWA C210.
e. Pipe for use with sleeve type couplings shall have plain ends at right angles to the axis.

6. Flanges

a. Flanges shall be in accordance with AWWA C207 Class D for operating pressures to one hundred fifty (150) psi on diameters over twelve inches (12″). Flanges shall be AWWA C207 Class E for operating pressures over one hundred fifty (150) psi to two hundred seventy-five (275) psi or shall be AWWA C207Class F for pressures to three hundred (300) psi (drilling matches ANSI B 16.5 Class 250). Shop lining and coating shall be continuous to the end of the pipe or back of the flange. Flange faces shall be shop coated with a soluble rust preventive compound.
b. Gaskets shall be full face, one-eighth inch (1/8″) thick, cloth inserted rubber, Garlock 3000, John Crane Co. Style 777 or equal.

7. Bolts and Nuts for Flanges

a. Bolts for flanges shall be carbon steel, ASTM A 307, Grade B for Class B and D flanges and nuts shall be ASTM A 563, Grade A heavy hex. Bolts for Class E and F flanges shall be ASTM A 193, Grade B7 and nuts shall be ASTM A 194, Grade 2H heavy hex.
b. All unwelded pipe joints shall be bonded for electrical continuity in accordance with the Pipe Manufacturer's recommendations unless otherwise specified in the Plans

8. Rolled Groove Rubber Gasket End

a. Rolled groove rubber gasket joints shall conform to AWWA C200 and as shown in Chapter 8 of AWWA M11.
a. The O-ring gasket shall have sufficient volume to approximately fill the area of the groove and shall conform to AWWA C200.
b. The joint shall be suitable for a working pressure equal to the class of pipe furnished and shall operate satisfactorily with a deflection angle, the tangent of which is not to exceed 0.8/D where D is the outside diameter of the pipe in inches with a pull out of eight tenths of an inch (0.8″).

c. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

d. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered.

e. Unless otherwise approved by the City, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. No process will be permitted in which the bell is formed by rolling.

f. Unless otherwise approved by the City, spigot ends with rolled gasket grooves shall be nondestructively tested by the dye penetrant or magnetic particle method for the full circumference, especially at the weld seam area.

g. Laying surfaces of the rolled groove rubber gasket shall be essentially parallel, but in no case shall the bell slope vary more than two degrees (2°) from the longitudinal axis of the pipe.

h. Actual yield strength of the steel used in the spigot rolling operation (i.e., yield strength values in mill certifications and subsequent destructive test results) shall be limited to fifty thousand (50,000) psi.

i. For rolled groove ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

9. Fittings

a. Unless otherwise shown on the Plans, all specials and fittings shall conform to the dimensions of AWWA C208. Pipe material used in fittings shall be of the same material and pressure class as the adjoining pipe. The minimum radius of elbows shall be two and one-half (2-1/2) times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed eleven and one-quarter degrees (11-1/4°) (one (1) cut elbow up to twenty two and one-half degrees (22-1/2°). If elbow radius is less than two and one-half (2-1/2) times the pipe diameter, stresses shall be checked per AWWA M11 and the pressure class increased if necessary. Elbows to be standard weight seamless elbows per ASTM A 106, Grade A or B. Fabricated elbows shall be manufactured per AWWA C208, Figures 2C through 2F.

b. Fittings shall be equal in pressure class design as the adjoining pipe. Specials and fittings, unless otherwise shown on the Plans, shall be made of segmentally welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe. All welds

made after hydrostatic testing of the straight sections of pipe shall be tested per the requirements of AWWA C200 Section 5.2.2.1.

c. All tees, laterals and outlets shall be reinforced in accordance with ASME Pressure Vessel Code, Section VIII, Paragraph G37 or AWWA M-11, Section 19.4 and 19.5.

10. Lining

a. Except as otherwise required, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C205.

b. The progress of the application of mortar lining shall be regulated in order that all hand Work, including the repair of defective areas is cured in accordance with the provisions of AWWA C205. Feathered or uneven edges will not be permitted.

c. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting.

d. The lining machine shall be of a type that has been used successfully for similar work.

e. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the City.

f. The minimum lining thickness shall be in accordance with AWWA C200, Table 1 of Section 4.

g. The pipe holdbacks shall be left bare where field joints occur as indicated. Ends of the linings shall be left square and uniform filled with cement mortar after joint completion per AWWA C205.

h. Defective linings, as determined by the City, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feathered edged joints.

i. Cement mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

j. For all pipe and fittings with plant applied cement mortar linings, the pipe manufacturer shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

k. Cement Mortar Lining for Field Application: The materials and design of in place cement mortar lining shall be in accordance with AWWA C602 and the following supplementary requirements.

1) Portland cement shall conform to Type II, ASTM C150.
2) Pozzolanic material shall not be used in the mortar mix.
3) Admixtures shall contain no calcium chloride.
4) The minimum lining thickness shall be as indicated for shop applied cement mortar lining and the finished inside diameter after lining shall be as shown.

11. Coatings

a. The prefabricated multilayer cold applied tape coating system for straight-line pipe shall be in accordance with AWWA C214. The system shall consist of a three (3) layer system totaling eighty (80) mil. Exterior surfaces of all pipe will be commercial blasted SSPC-SP-6 (Surface Preparation Specification No. 6 Commercial Blast Cleaning) before being primed.

b. Tape Coating of Fittings, Specials and Joints

1) Fittings, specials and joints that cannot be machine coated, shall be coated in accordance with AWWA C209. Prefabricated tape shall be Type II and shall be compatible with the tape system used for straight-line pipe. The system shall consist of two (2) layers totaling 70 mils.
2) Alternate coating methods for fittings, specials and field joints are shrink sleeves per AWWA C216, liquid epoxy per AWWA C210, or polyurethane per AWWA C222.
3) Joint bonds shall be completely encapsulated by the coating system as per manufacturer's recommendations.
4) Coating repair for fittings and specials shall be in accordance with the procedure described below for straight-line pipe.

c. Tape Coating repair shall be made using tape and primer conforming to AWWA C209 Type II and manufacturer's recommendations. The tape and primer shall be compatible with the tape system used for straight-line pipe. Refer to Paragraph 3.1,F,5 for additional details.

1) An alternative repair method shall be to install heat shrink sleeves in accordance with AWWA C216 and manufacturer's recommendations.

d. Polyethylene Coating (Pritec or approved equal):

1) A factory applied butyl rubber adhesive shall be extruded using a pressure roller spirally around the pipe at the manufacturer's recommended temperature. Immediately after the adhesive, overlapping layers of polyethylene shall be applied using a pressure roller at the manufacturer's recommended temperature to produce a bonded, seamless coating system totaling eighty (80) mil.
2) Pipe coating shall be one hundred percent (100%) inspected for holiday's immediately after application in the factory with a holiday detector adjusted to provide sufficient voltage to produce a spark through a pinhole in the coating.
3) Repairs to small holidays may be made in the factory by using a manufacture approved shrink type polyolefin material. Repairs will be inspected with a holiday detector
4) Field joints shall be coated in accordance with the manufacturer's recommendations using approved shrink type polyolefin material. Repairs will be inspected with a holiday detector.
5) Defective coating shall be recoated in the factory before shipping to meet Specification.

12. Joint Restraint

Where indicated, restrained joints shall be field welded joints. Designs shall include considerations of stresses induced in the steel cylinder, the joint rings, and any field welds, caused by thrust at bulkheads, bends, reducers, and line valves resulting from the design working pressure. All joints to be field welded for thrust restraint shall have the joint rings attached to the cylinder with double fillet welds. Calculations for the number of joints that need to be welded on each side of all vertical and horizontal angle points shall be furnished to the City at no additional cost to the City.

G. Tracer Wire for Nonmetallic Pipelines: Tracer wire shall be AWG No. 4 insulated stranded copper wire with a forty-five (45) mil polyethylene insulation. The wire shall be blue, have "UL" markings and suitable for direct bury applications.

H. Marker Tape for Nonmetallic Pipelines: Visual detection tape shall be three inches (3″) wide (minimum) metallic blue plastic tape lettered "water" in black graphics. Copper Pipe and Fittings shall be as per 33 12 00 (Water Services, Water Meter Setting, and Vaults).

I. Masonry Work shall meet requirements of 04 21 13 (Brick Masonry).

J Precast concrete shall meet requirements of 33 05 16.13 (Precast Concrete Utility Structures).

K. Granular Bedding shall meet requirements of 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill).

L. Cut and Cover Casing Pipe shall be the requirements of 33 41 00 (Storm Utility Drainage Piping) for reinforced concrete pipe.

PART 3 EXECUTION

3.1 GENERAL

A. Pipe delivery and distribution shall be scheduled to provide minimum interference with required maintenance of traffic. Pipe delivery shall be coordinated with pipe installation as directed.

B. Ductile iron pipe, fittings, valves and appurtenances shall be unloaded, handled and stored in accordance with AWWA C600. If damage or coating abrasion occurs and is deemed repairable, it shall be repaired at the Contractor's expense and to the satisfaction of the Engineer, in accordance with these Specifications. If damage is not repairable in the opinion of the Engineer, such pipe, fittings, valves or appurtenances will be rejected and shall be removed and replaced at the Contractor's expense.

1. At all times during construction of the pipeline the Contractor shall take every precaution to prevent damage to the protective coating. Suitable approved tools and equipment shall be used for convenient and safe handling of coated ductile iron pipe and fittings. Metal chains, cables, tongs, forklifts or other equipment likely to cause damage to the coating will not be permitted. Web slings shall be a type that will not damage the coating. Slings should be a minimum of eighteen inches

(18″) wide and of sufficient strength to handle the weight of the piping safely. Slings shall not pass through the pipe. Hooks on the end of the pipe will not be allowed.

2. In preparation for transporting pipe, the use of web slings is necessary for tie downs. If cables or chains are used during transportation, they must be properly padded with approved, suitable material as required to protect the coating from damage while in transit.
3. Use of a padded horizontal separator strip between successive rows of pipe is necessary to prevent damage to the pipe coating, i.e., rug material with outerwrap strips over it for all contact areas where pipe will rest.
4. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating.
5. Workmen shall not be permitted to walk on the coating, except when absolutely necessary and approved by the Engineer, in which case, they shall wear shoes with rubber or composition soles and heels or other suitable footwear which will not damage the coating.

C. Prestressed Concrete Pressure Pipe and specials shall be unloaded and handled with a crane or backhoe of proper capacity outfitted with a steel cable sling, belt sling or other specially designed attachment to protect the concrete. Delivery of pipe and specials shall be coordinated with installation and shall be unloaded with proper equipment outside the excavation as near as practicable to point of final placement, facing in proper direction and properly wedged secure. A notice of at least twenty-four (24) hours prior to pipe deliveries shall be given to the Engineer along with the method of unloading.

D. PVC pipe shall be unloaded, handled and stored in accordance with AWWA C605. If damage or coating abrasion occurs and is deemed repairable, it shall be repaired at the Contractor's expense and to the satisfaction of the Engineer, in accordance with these Specifications. If damage is not repairable in the opinion of the Engineer, such pipe, will be rejected and shall be removed and replaced at the Contractor's expense. Store pipe so it does not deform or bend. If pipe is stored out of doors or otherwise exposed to direct sunlight cover with an opaque material with provision for adequate air circulation.

E. High Density Polyethylene Pressure Pipe (HDPE) shall be unloaded and handled with a crane or backhoe of proper capacity outfitted with a steel cable sling, belt sling or other specially designed attachment to protect the pipe. If damage or coating abrasion occurs and is deemed repairable, it shall be repaired at the Contractor's expense and to the satisfaction of the Engineer, in accordance with these Specifications. If damage is not repairable in the opinion of the Engineer, such pipe, will be rejected and shall be removed and replaced at the Contractor's expense.

F. Steel Pipe shall be handled with wide belt slings or rubber padded forklifts. Chains, cables, or other equipment likely to cause damage to the pipe or coating shall not be used. Pipe shall be supported at proper intervals when lifted, so that excessive deflection does not take place. Pipe deflection shall not exceed one percent (1%) of the diameter. Adequate strutting shall be provided on all specials, fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling, and installation. In addition, the following requirements shall apply:

1. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed and backfilled at the jobsite.

a. The strutting materials, size, and spacing shall be adequate to support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment.
b. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.
c. The details of the strutting assembly shall be submitted for review by the Contractor prior to the start of pipe manufacture.

2. Pipe shall be stored on padded skids. Prior to shipment, the pipe will be visually inspected for damage to the coating.

a. Any areas that appear to be damaged will be given an electrical holiday test in accordance with Paragraph 1.3, E, 3. If the test indicates no holidays, and the outer wrap is wrinkled but not torn, no repairs are required.
b If the test indicates no holiday, and the outer wrap(s) is torn, the damaged layer or layers of the outer wrap shall be removed carefully, cutting with a sharp razor type utility knife. The area to be patched shall be washed with Xylol, taking care to wash at least four inches (4″) of undamaged tape where the hand applied tape wrap will overlap. Cold applied tape (outer wrap) meeting the requirements of AWWA C-209, and compatible with the tape wrapping system, shall then be applied by encircling the entire pipe circumference with a four (4″) overlap for each layer of tape that has been removed. When the damaged area shows holiday when tested, the outer layers shall be removed and the inner wrap exposed. The exposed area and overlaps shall then be primed with a light coat of primer. A patch of inner wrap of sufficient size to extend four inches (4″) from the holidays in all directions shall then be firmly pressed into place. The patch shall then be holiday tested to determine that it is satisfactory. The outer layer of tape shall then be retrimmed to expose the first wrap of tape sufficiently to allow a minimum lap of four inches (4″) in all directions. The exposed tape shall then be washed with Xylol and primed. Two (2) layers of outer wrap, with a minimum thickness of thirty-five (35) mil and conforming to AWWA C-209, shall then be applied by encircling the entire pipe circumference with a four-(4″) overlap.
c. Pipe shall be transported from the coating plant to the point of delivery on padded bunks with nylon tie-down straps or padded banding to adequately protect the pipe and coating.

3. Pipe shall not be laid on pavement without benefit of padded twelve inch (12″) wide (minimum) skids or select loamy or sandy dirt berms at contact points.
4. Pipe shall not be rolled or dragged on the ground. No pipe shall be placed against trees or shrubs nor in a manner that may damage private and other property.
5. Close open end of pipes and fittings with watertight seal during periods when Work is not progressing
6. Remove pipe, fittings, and valves when contaminated with oil, gasoline, kerosene, or other material that damages coatings, and replace at no cost to the City
7. Prior to placing pipe and fittings in trench, the interior and exterior of pipe and fittings will be inspected by the Engineer as described in Section 1.3. Pipe or fittings damaged beyond acceptable repair will be rejected and shall be removed and replaced at no City cost.

3.2 PREPARATION

A. Trench excavation and suitable bedding shall be complete to proper grade per 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill) before pipe is placed. Any adjustment due to improper trench grade or settlement shall be accomplished at Contractor expense. If the pipeline floats or collapses from accumulation of water in trench or from other causes, approved repair and replacement shall be at no cost to the City.

B. The pipeline trench excavation shall be dewatered sufficiently to allow pipe joints to be made under dry conditions. No joint shall be made under water.

C. No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when there is danger of ice formation or frost penetration at the bottom of the excavation. In freezing weather, open trench length shall be kept to a minimum and the excavation promptly backfilled after the pipe has been installed.

D. A firm, even bearing throughout the length of the pipe shall be provided by tamping select fill in the haunch area and at the side of the pipe to achieve the required bedding support angle. Bell holes shall be dug sufficiently large to insure that joints are properly made and the pipe is firmly bedded for the full length of the barrel. Prestressed concrete cylinder pipe and fittings shall be installed in accordance with requirements of AWWA M9, except as otherwise provided herein. Blocking will not be permitted.

E. When horizontal or vertical deflection of pipe from a straight line is necessary, the maximum permissible joint deflection shall not exceed the manufacturer's recommendations. Keep the pipe straight while pushing the pipe home. The joint deflection shall only be completed after the pipe is homed. Otherwise, change in alignment or grade shall be accomplished by use of pipe fittings which are the same diameter and strength as straight pipe. The maximum allowable deflection of HDPE pipe shall not exceed the manufacturer's recommendations. Where the maximum allowable deflection of HDPE pipe is insufficient to achieve the required change in direction, a molded or fabricated butt fused bend shall be used. Deflection of HDPE pipe shall not be permitted at any in-line, butt fused, fabricated, or molded fitting.

3.3 PIPE INSTALLATION

A. All pipe shall be installed in accordance with the recommendations of the pipe manufacturer, Contract Documents and as specified herein. These recommendations shall include maximum trench width, if more restrictive than that shown in the Standard Details; bedding requirements; backfill material and compaction, where applicable. In addition, the following shall apply unless otherwise noted:

1. Ductile Iron Pipe (DIP) and fittings shall be installed in accordance with the Standard Details for buttresses and anchorages and the recommendations of the Ductile Iron Pipe Research Association.
2. After the backfill has been placed, the struts in steel pipe shall be removed and shall remain property of the Contractor. The openings of all pipe and specials where the pipe and specials have been cement mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe.

The Contractor shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads.

B. Proper and suitable tools and appliances for safe and convenient handling and joining of pipes and fittings shall be used. Slings shall not damage the exteriors and/or coating of the pipe, and shall be wide canvas or rubber coated belts.

C. Pipe and fittings shall be carefully handled and lowered into the trench. Pipe shall be installed with special care to insure that each length abuts against the next to produce no shoulder or unevenness of any kind along the inside bottom half of the pipeline. No wedging or blocking will be permitted in installing any pipe unless directed by written order or permission in writing is obtained from the Engineer. Under no condition shall pipe be subjected to a blow or shock to bring it to required line and grade.

D. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Care shall be used to secure watertightness and prevent damage to, or disturbing of, the joints during the refilling process. After pipes have been installed and joints have been made, there shall be no walking on or working over the pipe, except as may be necessary in tamping the backfill material, until the backfill is at least two feet (2′) over the top of the pipe.

E. The pipes shall be thoroughly cleaned before being installed and shall be kept clean until acceptance of the completed Work. Open ends of all pipelines shall be provided with a stopper carefully fitted to keep dirt and other substances from entering. This stopper shall be kept in the end of the pipeline at all times when installation is not in progress. Surfaces of both pipe sections to be in contact with rubber gasket seal shall be thoroughly wire brushed to remove all loose rust and foreign matter, leaving clean smooth surfaces for jointing.

F. Straight pipe shall be furnished in standard uniform lengths. Approved short pipe lengths shall be used where needed to meet line and grade as closure pieces. Whenever a pipe requires cutting, to fit into the line or bring it to the required location, the Work shall be done in a manner that leaves a smooth, square end. Field cut pipe lengths shall be filed or ground to resemble the plain end of pipe as manufactured.

1. Cut PVC pipe ends shall have burrs removed and the end beveled to match factory bevel. Field spigots shall be stop-marked with a felt tip marker or wax crayon for the proper length of assembly insertion.
2. Any lining damaged due to field cutting shall be repaired by the Contractor as specified herein.

G. After completion of water main Work, unused pipe, and fittings and joint restraint pieces shall remain the property of the Contractor and be removed from the site. No additional compensation will be made.

H. In addition to the other requirements specified herein, when installing PVC water mains, the Contractor shall also furnish and install the following:

1. A copper tracer wire located on the left side, looking up station, and in the gravel bedding for the pipe. The wire shall be continuous in length with no breaks. The wire shall be laid with all mainline piping including stubs and fire hydrant laterals and

shall be attached to the pipe at the most remote valve locations at all ends of the main. Connections to existing tracer wire or splicing of wire shall be accomplished via wire nuts rated for the gauge wire used and wrapped in electrical tape.

2. A minimum two inch (2″) wide blue marker tape shall be located in the trench, two feet (2′), plus or minus one-half foot (± 0.5′), above the pipe along the length of all mainline piping including all stubs and fire hydrant laterals.

I. Minimum Pipe Cover and Clearances

1. Water mains shall have no less than forty-two inches (42″) of cover measured from the existing and/or established grade to the top of the pipe whichever is lower, except as noted on the Plans. When crossing subsurface obstructions, twelve inch (12″) minimum clearance shall be maintained between the pipe and the obstruction.
2. When crossing sanitary sewers, water pipe sections shall be centered over the sewer so that joints on both sides are the maximum distance from the sewer.

J. Jointing Pipe

1. General

Before any joints are made in the trench, the Contractor shall demonstrate to the Engineer by making a sample joint that the Contractor will employ conform to the Specifications, will secure a watertight joint, and that the workmen whom the Contractor intends to use for this Work are familiar with the requirements for making proper joints.

2. Push-On Gasketed Joints

a. Prior to making gasketed joints, both mating pipe ends and the gasket shall be cleaned of all foreign material. The gasket shall then be inserted in or stretched over the cleaned gasket seat and lubricant applied to the gasket and the mating pipe end. The lubricant shall be approved for use in potable water and shall be harmless to the rubber gasket. Use only lubricant supplied by the pipe manufacturer. Pipe shall be laid with bell ends looking ahead in the direction of laying. As soon as the spigot ring is centered in the bell of the previously laid pipe, it shall be forced home with approved equipment. After the gasket of Prestressed Concrete Pipe is compressed, verify the position of the gasket in the spigot ring groove with a feeler gage provided by the pipe manufacturer. Assembly of PVC plain end into bell shall follow PVC pipe manufacturer's recommendations. Do not deflect PVC pipe at connection to ductile iron fitting.

b. PCCP pipe joint openings in the laying schedule shall not exceed 2/3 the manufacturer's recommendations for the joint type furnished. The Engineer may authorize additional opening of the PCCP pipe joints to make field adjustments. The final alignment and grade shall not contain any PCCP pipe joints opened more than the manufacturer's published recommendation. The joint space remaining on the inside and outside of PCCP pipe shall be filled with grout in accordance with the pipe manufacturer's recommendations. Bevel adapters shall not be used on PCCP pipe.

c. Ductile iron pipe joints shall be assembled per AWWA C600 to insure joints that safely permit movement caused by expansion and contraction as well as slight ground settling or shifting.

3. Mechanical Joints

a. Contact surfaces shall be cleaned and coated with an approved lubricant just prior to slipping gasket over plain end and into socket. A cast iron gland shall be positioned on the spigot end of the pipe, followed by a rubber gasket thoroughly lubricated with its tapered side facing the bell. The spigot shall then be inserted fully into the bell. The rubber gasket shall then be moved into position by hand until it is flush with the face of the bell. The gland shall then be placed against the face of the rubber gasket and the bolts inserted and made finger tight. Bolts shall be drawn up evenly on alternate sides beginning at the top, keeping the gland parallel to the face of the bell at all times. All nuts shall be tightened uniformly with a torque in accordance with the manufacturer's recommendations.

b. A retainer gland shall not be used on any pipe joint or fitting connecting ductile iron pipe to existing cast-iron pipe.

c. Unless otherwise specified, diameter of ductile iron plain ends shall be the same as for mechanical joint cast or ductile iron pipe

d. After each ductile iron or steel pipe, fitting and valve is jointed complete, each joint area including restraint elements shall be cleaned, inspected and approved before next section is installed.

4. HDPE Pipe Joining

a. When cutting PE pipe, the cut end of the pipe shall be squared as much as possible prior to facing. Field cutting of PE pipe eight inches (8″) in diameter or less can be accomplished without damaging the pipe ends due to melting by using a pipe saw. To cut PE pipe with a diameter larger than eight inches (8″), a chain saw with a glycerin-based lubricant is recommended. Do not use oil as a lubricant, nor use a chain saw that has had oil in the oiler. Oil will penetrate the pipe wall and decrease the strength of the pipe wall material.

b. Heat Fusion Joining: Joints between plain end pipes and fittings shall be made by butt fusion and joints between the main and saddle branch fittings shall be made using saddle fusion in accordance with recommended procedure by pipe and fitting manufacturer. The external & internal beads formed during heat fusion shall not be removed.

c. Butt Fusion of Unlike Wall Thicknesses: Butt fusion shall be performed between pipe ends, or pipe ends and fitting outlets that have the same outside diameter and not different wall thicknesses by more than one (1) Standard DR. Transition between unlike wall thicknesses greater than one (1) SDR shall be made with transition nipple (a short length of heavier wall pipe with one end machined to lighter wall) or by mechanical means or electrofusion.

d. Joining By Other Means: Polyethylene pipe and fittings may be joined together or to other materials by means of:

1) Flanged connections (flange adapters and back-up rings), or
2) Mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another material, or
3) Mechanical Joint Adapters, or
4) Electrofusion.
5) When joining by other means, the installation instructions of the joining device manufacturer shall be observed.

e. ID Stiffeners and Restraints: A stiffener shall be installed in the bore of the polyethylene pipe when an OD compression mechanical coupling is used and when connecting plain end HDPE pipe to a mechanical joint pipe, fitting or appurtenance. External clamp and tie rod restraint shall be installed where HDPE pipe is connected to the socket of a mechanical joint pipe, fitting or appurtenance except where a Mechanical Joint Adapter is used.

f. Branch Connections: Branch connections to the main shall be made with saddle fitting or tees. Polyethylene saddle fittings shall be saddle fused to the main per Heat Fusion Joining procedure.

g. Joining of HDPE Pipe to Valves: A flange adapter and back-up ring shall be used to connect PE pipe to valves. Flanged faced valves shall be used in connecting to PE pipe. When butterfly valves are used, a spacer shall be inserted between the face of the flange adapter and the face of the butterfly valve to accommodate the full operational range of the valve disc. Also, full face gaskets shall be used between the face of the valve and spacer and the face of the spacer and the flange adapter. Only ANSI 304 Grade stainless steel studs, bolts and nuts shall be used to secure the flange adapter to the flange face of the valve.

h. Joining of HDPE Pipe to Mechanical Joint Fitting: HDPE pipe shall be restrained to mechanical joint fittings to prevent pipe pull out. This connection shall be by means of mechanical rings and bolts using a molded coupling or Mechanical Joint (Harvey) adapter fused to the pipe. When connecting pipe to fittings without the use of a Mechanical Joint adapter, pipe stiffeners or inserts must be used to prevent toe-in of the pipe material.

5. Steel Pipe Joining

a. Rolled Groove Rubber Gasket Joint

1) Clean exposed ends of joint surfaces.
2) Thoroughly lubricate the gasket with material approved by the Pipe Manufacturer.
3) Place gasket in grooved spigot and relieve tension by inserting a dull instrument under the gasket and completing at least two (2) revolutions around the joint circumference.
4) Upon completion of insertion of spigot (including any angular deflection as shown on the approved shop drawing) and prior to releasing from slings the entire placement of the gasket should be checked with a feeler gauge per manufacturer's recommendations. If gasket has disengaged or rolled, immediately pull the joint apart and reinstall the joint with a new gasket if required. Again verify proper placement of gasket with feeler gauge.

5) It is recommended that bonding wires or clips be installed as supplied by the Pipe Manufacturer unless otherwise specified in the Plans.
6) Grout the interior of the joints with cement mortar per AWWA C205. Complete the exterior of the joints with heat shrink sleeves per AWWA C216 and manufacturer's recommendations.

6. Lap Field Welded Joints

a. Clean exposed end of joint surfaces.
b. Provide a minimum overlap of one inch (1″) at any location around the joint circumference.
c. Field welders and field weld procedures shall be certified in accordance with AWS D1.1.
d. At the Contractor's option, provide a full fillet weld per AWWA C206 either on the inside or outside of the pipe. Inside welding may be performed after backfilling in accordance with manufacturer's recommendations.
e. Testing of field welds shall be in accordance with AWWA C206.
f. Grout the interior of the joints with cement mortar per AWWA C205. Complete the exterior of the joints with heat-shrink sleeve per AWWA C216 and manufacturer's recommendations.
g. Flanged Joints: See Paragraph 2.1.C, 2,b.
h. Other methods of jointing pipe will be given consideration by the Engineer, provided the Contractor furnishes evidence that the proposed method is equal to or better than the specified methods, and further, provided that the proposed method has been successfully used and that the joint has previously been manufactured by the company from whom the Contractor proposes to purchase pipe.

7. Thrust Restraint

a. All thrust due to static and dynamic forces, including water hammer, at bends, tees, wyes, valves, fire hydrants, drain blowoffs, and dead end blowoffs shall be counteracted by an approved restraint method, whether or not indicated on Drawings. When connecting pipe or fittings to existing facilities, provide sufficient restraint to counteract all thrusts.
b. Buttresses and anchorages shall be installed at all caps, horizontal bends, tees, hydrants, branches, and beneath all vertical bends. Buttresses and anchorages shall be of concrete or concrete and steel. Buttresses and anchorages shall extend to solid, undisturbed soil and shall be constructed in accordance with the Standard Details, as shown on the Plans, or as directed by the Engineer.
c. Restrained joints and joint restraint systems shall be assembled in accordance with the system manufacturer's recommendations. Tie rod nuts shall be tightened by hand and then tightened one additional turn by wrench. Restraint elements shall be protected against corrosion using field applied primer and coating system per AWWA C210. All coatings shall be complete before line testing.

8. High Density Polyethylene (HDPE) Pipe

To help minimize the effects of thermal contraction and expansion for HDPE pipe, it shall be installed as shown on the Drawings. When connecting to dissimilar pipes, thrust restraint shall be installed at the point of connection. Water stops shall be encased in concrete with dimensions adequate to safely transmit all thrust forces caused by expansion and contraction into the surrounding soils.

9. Polyvinyl Chloride (PVC) Pipe

Refer to Paragraph 2.1, B, 4 of this Specification.

10. Ductile Iron Pipe

a. All twelve inch (12") and smaller diameter mechanical joint ductile iron water mains and fittings, including valves and fire hydrants, shall be installed using ductile iron retainer glands in place of standard follower glands.
b. Provide factory welded steel thrust collars or retainer glands embedded in in-line thrust blocks on ductile iron water mains where shown on Drawings.
c. Restraint of thrust forces in push-on joint ductile iron pipe shall be provided by an approved proprietary harnessing system installed in accordance with manufacturer's printed instructions. Work includes all excavation necessary to install harnessing.
d. Restraint of mechanical joint ductile iron pipe shall be accomplished by using approved ductile iron retainer glands in lieu of follower glands, installed in accordance with manufacturer's printed instructions.
e. Torque range for retainer gland set screws shall be in accordance with manufacturer's recommendations.
f. Where specifically indicated, undrilled steel thrust collars with concrete thrust blocks, drilled steel thrust collars with harnessing, steel tie rods strapped securely outside of the mechanical joint flanges, or use eye tie-bolt which allows tightening the joint before restraint is applied, shall be used to provide thrust force restraint. Collars, rods and other steel harness items shall be per manufacturer's recommendations and approved in advance by the Engineer.
g. After each ductile iron restrained joint is complete, the joint restraint elements shall be cleaned and inspected.

11. Prestressed Concrete Pipe

Refer to Paragraph 2.1, E, 3, of this Specification.

12. Extra Fittings/Specials

a. Prior to making connections to existing pipe, for closure sections and for field changes due to unanticipated interference, the Contractor shall:

1) Verify the size of existing pipe in service and provide pipe and fittings with the correct diameter sleeves, sleeve type couplings, or closure piece to connect to existing pipe or to complete a closure. Limits of pipe and fittings for this purpose shall be approved on

detailed Drawings submitted by the Contractor to permit closure or to meet fixed outlet points by field alteration of approach lengths to compensate for differences between design and actual laying lengths; and/or

2) Verify unanticipated interference and provide additional fittings as needed and as approved on detailed drawings submitted by the Contractor to permit field changes in line and grade needed due to unanticipated obstructions in the actual locations of interfering underground structures or junction water main, including use of additional fittings.

b. Fittings and adjustments necessary to facilitate closures and proper connections shall be included in the Work whether or not indicated on the Drawings.

1) Drawings show the more likely arrangement of fittings and specials, but these details cannot be guaranteed due to inevitable field conditions and adjustments.

2) Where connections to existing pipe, closure sections or unanticipated obstructions require a change in line or grade of proposed water main alignment, Extra Fittings, Contractor Furnished and requisite retainer glands for twenty-four inch (24″) and smaller diameter ductile iron pipe water main shall be furnished and installed.

K. Maintaining Water Service

1. Connections to existing work shall be made by the Contractor in the presence of the Engineer at such a time and in such manner as directed and approved by the Engineer. The Contractor shall submit to the Engineer, for review and approval, a schedule for any proposed system disruption along with a draft letter of notice to the effected customers. Upon approval by the Engineer, the Contractor shall notify, in writing, the customers in the area to be effected by the shut-off. The Contractor shall notify the Engineer for approval at least forty-eight (48) hours prior to cutting or abandoning a water main. All valves necessary for making connections will be operated by the City's representative or the City valve crews. The Contractor shall complete the connections with the greatest possible speed so that the public will be inconvenienced as little as possible. Existing water service shall be maintained at all times except when disconnecting or connecting new Work. Existing water mains paralleling new water mains shall be kept in service until new water mains are complete, temporarily capped as needed, tested, chlorinated and charged. When specified in the "Special Provisions," the Contractor shall make connections at night. Unless otherwise indicated, the Contractor shall cut existing water mains, remove pipe, fittings, and appurtenances to make required connections; connect new water mains; reconnect existing water mains; and perform all Work necessary or incidental thereto.

2. When a tapping sleeve and valve is to be used for making the connection, the Contractor shall not proceed with the installation until directed to do so by the Engineer. The tapping sleeve and valve shall be prepared in accordance with 33 12 16 (Water Valve and Appurtenances). Where it is necessary to remove an

existing buttress to make a connection, the removal shall be done by the Contractor without additional compensation therefore.

L. Abandonment

1. Cap ends of mains as shown. Place required concrete blocking to retain the cap on the water main to remain in service.
2. Where mains are to be abandoned and removed to a fitting or valve cut and plug main at fitting or valve. When shown on the Contract Plans, remove and salvage abandoned valves, valve boxes, and fire hydrants within the limits of abandonment and deliver to City warehouse. Pipe, fittings and other appurtenances that are removed but not required to be salvaged, shall become the property of the Contractor and shall be removed and disposed of offsite.
3. For abandonment of water mains twenty inches (20″) and larger diameter, construct a brick bulkhead nine inches (9″) thick or install an approved plug or cap at each location where the pipe was cut or valve removed.
4. For abandonment of water mains smaller than twenty inch (20″) diameter, install bulkheads using brick masonry, twenty-five hundred (2500) psi concrete, gray iron plugs or caps at the end of abandoned sections.

PART 4 MEASUREMENT AND PAYMENT

4.1 PIPE

A. Unless otherwise specified in the Special Provisions payment for water mains will be made at the unit price Bid per linear foot in the proposal for various types and sizes of pipes; which prices shall include all material; labor; tools; equipment; hauling; excavating to planned trench subgrade; excavation for bell holes; sheeting and/or shoring; sills and wedges; pumping; stone or gravel cradle; backfilling with suitable material from the Project; rehandling of material; removal and disposal of unsuitable material; compacting; all fittings, stoppers, sleeves, closure pieces, gaskets, and jointing; buttresses; valve vaults; pitometer corporations; coatings; connections to existing lines; chlorinating; testing; maintaining service; and all incidentals necessary to complete these items of Work. Excavation of bellholes, when required, will not be paid for as such, but the cost thereof shall be included in and covered by the unit prices Bid for furnishing and laying pipe.

B. Unit of measure for Extra Fittings will be the pound, as determined from the nominal tabulated weight of each fitting per ANSI/ AWWA C153 (the weight of the fitting before the application of any lining or coating other than standard coatings). Weight of retainer glands, bolts, nuts and gaskets will not be measured. The weight of any fitting shall not be less than the nominal tabulated weight by more than ten percent (10%). No separate measure will be made for Extra Fittings.

C. Whenever a pipe requires cutting, this Work shall be done as directed by the Engineer and the cost shall be included in the unit prices Bid for furnishing and laying the various size pipes.

D. Payment for fire hydrants, water service connections, and valves will be made as specified under Section 33 12 16, (Water Valve and Appurtenances), Section 33 12 00, (Water Services, Water Meter Settings, and Vaults) and Section 33 12 19, (Water Utility Distribution Fire Hydrants).

E. Payment for pavement, sidewalk and curbing restoration shall be as specified under Section 32 01 30.10, (Patch Existing Pavement and Reset Utility Services).

F. Excavation required below the planned elevation will be measured and paid for as specified in 31 23 3, (Trenching and Backfilling).

G. Selected backfill will be measured and paid for as specified in 31 23 33, (Trenching and Backfilling).

H. Encasement concrete and concrete or brick masonry to plug existing pipes will be measured and paid for at the Contract Price for the pertinent Concrete Mix No. 2 for Miscellaneous Structures or Brick Masonry for Miscellaneous Structures item.

I. Removal of Existing Pipe not in the same trench as the proposed pipe installation feet removed, regardless of the condition. When a multiple pipe installation is removed, each pipe will be measured and paid for.

4.2 PIPE IN TUNNELS AND SLEEVES

1. Pipe in tunnels and sleeves will be measured for payment by the linear foot measured horizontally along the centerline of the pipe from inside face to inside face of access shafts.

2. Payment will be made for the quantities measured at the unit price per linear foot listed in the Bid Schedule.

3. Payment includes installation of City furnished pipe or pipe provided by the Contractor as the case may be, concrete invert between tunnel liner or sleeve and pipe, and all incidentals required to install the pipe in the tunnel liner or sleeve complete as shown on the Contract Plans.

4.3 CASING PIPE INSTALLED IN OPEN CUT

1. Casing pipe installed in open cut will be measured for payment by the linear foot measured horizontally along the centerline of the pipe from bulkhead to bulkhead.

B. Payment will be made for the quantities measured at the unit price per linear foot.

C. Payment includes excavation, backfill and bedding, provision of pipe, bulkheads and incidental appurtenances.

33 12 00 WATER UTILITY DISTRIBUTION EQUIPMENT

33 12 00 WATER SERVICES, WATER METER SETTINGS, AND VAULTS

PART 1 GENERAL

1.4 DESCRIPTION

Water services, water meter setting, and vault installation shall include, but not necessarily be limited to, furnishing and placing water services with appurtenant meter housings and connection to the water main in accordance with the Baltimore City Standard Details and/or the Contract Documents.

1.2 QUALITY ASSURANCE

A. Quality assurance for pipes, fittings, valves, and appurtenances furnished by the Contractor shall be in accordance with the latest national standards and as specified herein.

B. Field Tests: Water services and water meter settings will be visually inspect a static pressure test by the Engineer.

C. Quality assurance for precast concrete utility structures is specified in 33 05 16.13 (Precast Concrete Utility Structures)

PART 2 PRODUCTS

2.1 MATERIALS FURNISHED BY THE CITY

The City will furnish and install meters for all services.

2.2 DETAILED MATERIAL REQUIREMENTS

A. Water Meters: As supplied or as approved by the Department of Public Works, Bureau of Water and Wastewater, Utility Engineering Division.

B. Water Service

1. Water services for three-quarter inches (3/4″) through two inches (2″) shall be soft Copper tubing as follows:

a. Copper pipe shall be seamless, type K annealed, and meet the material, chemical, and mechanical requirements of ASTM B 88.

b. Copper Pipe and Fittings: Fittings shall be copper meeting requirements of ASTM B62 and shall meet requirements of AWWA C800. Copper to copper couplings shall be those known as the two (2) part type consisting of a tubing connection, a coupling nut and a friction ring. The copper tub end of the couplings shall be the flare type for three-quarters of an inch to one inch (3/4″ to 1″) services and for one and one-half inch to two inch (1-1/2″ to 2″) services; compression type fitting should be used for connecting to type K copper service pipe. The opposite end, and all couplings nuts shall be threaded in accordance with AWWA C800. The iron end of all copper to iron pipe fittings shall be threaded in accordance with American National

Pipe Threads. Copper and brass fittings shall be standard seamless threaded reamed and chamfered, and of the proper size required. The brass fittings shall be 85-5-5-5 Red Brass.

2. Service pipes and fittings four inch (4″) diameter and larger for water shall be as specified in 33 11 13 (Public Water Utility Distribution Piping).
3. Gate valves, roadway valve boxes, and tapping sleeves for water services shall be as specified in 33 12 16 (Water Utility Distribution Valves).
4. Pipe for meter support in two inch (2″) metered water supplies shall be galvanized steel as specified in 33 12 16 (Water Utility Distribution Valves).
5. Corporation stops with flared coupling nuts shall be shall be preapproved by the Water and Waste Water Engineering Division.
6. Meter settings

    a. Outside setting: All fittings, yokes, and appurtenances shall be preapproved by the Water and Waste Water Engineering Division and shall be provided and installed by a contractor as specified in the Standard Details.

7. Pipe couplings for four inch (4″) or larger meter settings shall be a stab type coupling as preapproved by the Water and Waste Water Engineering Division or as specified in the Contract Documents.
8. Tapping saddles shall be manufactured of bronze with double bronze straps. Bronze saddles shall meet all applicable requirements of ANSI/AWWA C800. All saddles must meet a minimum of two hundred (200) psi working pressure.
9. Portland cement concrete for cast in place meter vault lids and bases shall be as specified in the Contract Documents and Standard Details.
10. Concrete reinforcement shall be as specified in the Contract Documents and Standard Details.
11. Precast meter vaults shall be precast concrete vaults of the size indicated on the Standard Details or as approved by the Water and Waste Water Engineering Division.
12. The prefabricated meter vaults shall also comply with the following:

    a. Prefabricated water meter vaults shall be furnished with a standard Meter Frame and Cover as shown on the Standard Details.
    b. The meter setting shall be furnished with a ball angle valve on the outlet and inlet sides of the setting.
    c. The ball angle meter valves shall be as shown on the Standard Detail to assure interchangeability of City standard meters.

13. Brick and concrete masonry units for meter vaults shall be as specified in 04 21 13 (Brick Masonry).
14. Size No. 57 or 67 Gravel: AASHTO M43.

PART 3 EXECUTION

3.1 WATER SERVICES, WATER METER SETTINGS, AND VAULTS

A. Water services, water meter settings, and vaults shall be installed in accordance with the requirements for the specific materials indicated above, in accordance with the Contract Documents, Standard Details, and the following:

1. All services shall be laid to the grade and lines in accordance with the Contract Documents or as directed by the Engineer.
2. All meter vaults shall be set at the location, and constructed of the materials shown in the Standard Details.
3. Special care shall be taken to insure that the services are well bedded on a solid foundation. Any defects resulting from settlement shall be repaired by the Contractor at the Contractor's expense. All meter vaults shall be bedded on firm undisturbed earth. The pipe and fittings shall be thoroughly cleaned before being installed, and shall be kept clean until the acceptance of the complete Work.
4. All services shall be thoroughly flushed with potable water. Services larger than two inch (2″) diameter shall be chlorinated as specified in 33 11 13 (Public Water Utility Distribution Piping).
5. All service ends not immediately connected to house service shall be provided with a cap to prevent any foreign matter from entering the pipe. Crimping of service ends will not be allowed.
6. Meter settings shall be level and the long axis of the setting shall be perpendicular to the proposed curb and gutter or edge of pavement in the case of open section roadways. Where the setting is remote from the roadway the long axis of the meter setting shall be aligned with the center line of the water service.

3.2 CONNECTIONS TO WATER MAINS

A. Service connections to existing water mains shall be made with tapping saddles or sleeves except for connections one inch (1″) and less to ductile or cast iron pipe which may be made by direct tap. Direct taps larger than one inch (1″) to ductile or cast iron pipe shall be in compliance with the Baltimore City Details.

B. Service connections to new water mains shall be made by direct tapping ductile iron water mains for up to one inch (1″) services only, by installing appropriate outlet fittings and valves as the water main is being constructed, or by installing tapping saddles, tees, or sleeves.

C. Make taps more than eighteen inches (18″) horizontally away from other taps or pipe joints.

D. Make all taps at ten or two (10 or 2) o'clock on the circumference of the pipe.

3.3 WATER SERVICE RELOCATION

A. Relocation of Existing Water Supply Services: The relocation of water supply services shall consist of, but is not limited to, the relocation of the existing meter(s) and vault and the installation of new service pipe of the size as indicated on the Plans from a new corporation at the existing water main, to the relocated new meter and vault and to the consumer's service pipe. All new corporations required by Contract Documents shall be furnished and installed by the Contractor. The existing corporation shall be plugged at the existing water main and the existing service pipe removed from it.

B. Where the Contractor encounters an existing water supply service pipe using galvanized pipe it shall relocate the existing service pipe, meter and vault as described in the preceding paragraph, using new copper tubing.

C. Where the Contractor encounters an existing water supply service pipe using copper pipe, it need only relocate the existing meter and vault to the new proposed curb line and grade

of the street involved, making use of the existing copper tubing and using new copper tubing where necessary to make connections to the consumer's service pipe.

PART 4 MEASUREMENT AND PAYMENT

A. No measurement or payment will be made for the Work necessary to adjust and reconnect existing water service connection to the replacement water main. All costs associated with completing the reconnection including but not limited to excavation, disconnecting from and closing the existing tap, adjusting service piping and providing a new corporation stop in the new main, backfilling, compaction and any other Work needed to complete the reconnection is considered incidental to the replacement water main construction. All costs shall be included in the appropriate Bid items.

B. Any extension of the existing water service connections to the replacement water main shall be made at the Contract Unit Price per linear foot of pipe installed complete, including excavation, backfill and compaction, connections at corporation stop, at water meter, and at connection and reducer as needed to connect to existing service pipe at the full or partial replacement limit, and all labor, materials, tools, equipment and incidentals needed to complete Work specified herein. Payment will be based on pipe in place, whether the pipe is installed by open cut or by approved trenchless techniques. All costs associated with all labor, materials, tools, equipment and incidentals needed to complete Work specified is considered incidental to the Contract and shall be included in the unit price for service connections as contained in the Proposal.

C. Payment for Water Service Pipe shall be made at the Contract Unit Price per linear foot of pipe installed complete, including excavation, allowance of two (2) linear feet for piping in the meter box (meter yoke, shunt, couplings and riser pipe when needed), backfill and compaction including backfill for meter pits, replacing service piping, tap and install new corporation stop, close the existing corporation stop and sever the connection, connections at corporation stop, at water meter, and at connection and reducer as needed to connect to existing service pipe at the full or partial replacement limit, and all labor, materials, tools, equipment and incidentals needed to complete Work specified herein. Payment will be based on pipe in place, whether the pipe is installed by open cut or by approved trenchless techniques. No measurement or payment will be made for the Work necessary to furnish and install water meter boxes and reinstall frames and covers. All costs associated with furnishing and placing meter pit foundation gravel, furnishing and installing water meter boxes, reinstalling frames and covers, coordination with the City for the reinstallation of meters, and all labor, materials, tools, equipment and incidentals needed to complete Work specified is considered incidental to the Contract and shall be included in the unit price for service connections as contained in the Proposal.

D. Relocation of existing water supply services shall be made at the Contract Unit Price per linear foot of pipe installed complete, including excavation, allowance of two (2) linear feet for piping in the meter box (meter yoke, shunt, couplings and riser pipe when needed), backfill and compaction including backfill for meter pits, replacing service piping, tap and install new corporation stop, close the existing corporation stop and sever the connection, connections at corporation stop, at water meter, and at connection and reducer as needed to connect to existing service pipe at the full or partial replacement limit, and all labor, materials, tools, equipment and incidentals needed to complete Work specified herein. Payment will be based on pipe in place, whether the pipe is installed by open cut or by approved trenchless techniques. No measurement or payment will be made for the Work necessary to furnish and install water meter boxes and reinstall frames and covers. All

costs associated with furnishing and placing meter pit foundation gravel, furnishing and installing water meter boxes, reinstalling frames and covers, coordination with the City for the reinstallation of meters, and all labor, materials, tools, equipment and incidentals needed to complete Work specified is considered incidental to the Contract and shall be included in the unit price for service connections as contained in the Proposal.

E. All applicable excavation, sheeting, shoring, dewatering, hauling, invert paving, storing, rehandling of material, removal and disposal of excess and unsuitable material (above the planned subgrade), tamped fill, forming bed or foundation, stone, gravel cradle, backfill, compaction shall be measured and paid for as specified in 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill)

33 12 16 WATER VALVES AND APPURTENANCES

PART 1 GENERAL

1.1 DESCRIPTION

Water valve and appurtenance installation shall include, but not necessarily be limited to, furnishing and installing resilient wedge gate, butterfly, and air release and vacuum valves or assemblies with appurtenant valve vaults or roadway valve boxes and accessories in accordance with the Contract Documents.

1.2 QUALITY ASSURANCE

A. Quality assurance for pipes, fittings, valves, and appurtenances furnished by the Contractor shall be in accordance with the latest national standards as specified herein.

B. Field Tests

1. Water valves and appurtenances installed at the same time as a new water main shall be tested, after installation, by the Contractor along with the water main in accordance with 33 11 00 (Water Utility Distribution Piping)
2. Water valves and appurtenances installed in an existing water main will be visually inspected for leakage by the Engineer at the existing water main line pressure before the excavation is backfilled. The valve and joints shall be leak free under line pressure.
3. Tapping sleeves and valves shall be tested after assembly on the existing water main but prior to making the tap. The Contractor shall pressurize the complete assembly to a minimum of one hundred fifty (150) psi, or one and one-half (1-1/2) times the working pressure, whichever is higher. The Engineer will visually inspect the tapping sleeve and valve for leakage. No leakage will be permitted.

C. Quality assurance for precast concrete utility structures is specified in 33 05 16.13, (Precast Concrete Utility Structures).

1.3 SUBMITTALS

A. Refer to the approved Department of Public Works Bureau of Water and Wastewater, Utility Engineering Division, Baltimore City Valves, at the Water Engineering Office.

B. Affidavits, certifications, and manufacturer's test results shall be submitted as specified in the 01 33 00 (Submittal Procedures) for all gate and butterfly valves as follows:

1. For Gate Valves: Three inch (3″) through twenty-four inch (24″).

   a. Catalog data three inch (3″) through twenty-four inch (24″). Prior to purchase of the valve, the Contractor shall submit to the Engineer, for approval, catalog data, net weight, and certified assembly drawings. No valve shall be furnished or installed unless approved in writing by the Engineer.
   b. Affidavit: An affidavit of compliance shall be furnished by the manufacturer that specifies tests have been performed and that all components and the product comply in all respects with requirements of Specifications.
   c. Records of Tests: Record of physical and chemical properties, operating and hydrostatic tests shall be furnished.

2. For Butterfly Valves: Thirty inch (30″) through seventy-two inch (72″).

   a. Test data shall be furnished by manufacturer.
   b. The Contractor shall submit manufacturer's certified drawings of the valves including valve operators, gear ratios, electrical schematics (where electrical operators are furnished), and parts lists.
   c. An affidavit from the manufacturer shall be submitted stating that valves furnished comply with all applicable provisions of this Specification.
   d. Certified test reports covering performance, leakage, and hydrostatic tests shall be furnished.
   e. A statement shall be submitted by the Contractor giving required number of turns of the operating nut to move the disc from fully open to fully closed (or vice versa) position.

PART 2 PRODUCTS

2.1 MATERIALS

A. Washed gravel for dewatering, air release valve and air/vacuum valve shall meet the gradation requirements of AASHTO M43, Size number 67.

B. Ductile iron and concrete pressure fittings shall be as specified in 33 11 13 (Public Water Utility Distribution Piping).

C. Tapping saddles and corporation stops shall be as specified in the Contract Documents.

D. Portland cement concrete for miscellaneous valve appurtenances and cast in place vaults shall be the Mix Number indicated on the Standard Details or Contract Documents and as specified in 03 30 00 (Portland Cement Concrete Structures).

E. Precast concrete vault and manhole sections and grade rings shall be as specified in 33 05 16.13 (Precast Concrete Utility Structures). Mix Number shall be as indicated on the Standard Details.

F. Brick for valve support and miscellaneous valve appurtenances shall be sewer brick as specified in 33 39 13, (Sanitary Utility Sewerage Manholes, Miscellaneous Structures, Frames and Covers).

G. Mortar for brickwork shall be as specified in 04 21 13 (Brick Masonry).

H. Castings for Frames, Covers, and Steps: Iron castings shall conform to ASTM A 48, Class 35B. Covers shall be labeled in accordance with the Standard Details. Steps and ladders shall be as dimensioned on the Standard Details. Manhole steps shall conform to A 312 Grade TP 410 Stainless steel or shall be reinforced plastic steps composed of ASTM A615, Grade 60 reinforcing bar (#4) completely encapsulated in copolymer polypropylene per ASTM D2146, Type II, Grade 43758.

I. Gate Valves: Three inch (3″) through twenty-four inch (24″).

1. Gate valves three inch (3″) through twenty-four inch (24″) diameter nominal pipe size shall be resilient wedge type. Resilient Seated Gate Valves shall be encapsulated solid gate iron body with a sealing mechanism manufactured and tested to the requirements of AWWA Standard C-509, C-515 as applicable for a design working pressure of two hundred fifty (250) psi. The manufacturer's name, pressure rating, year of manufacture and size shall be cast on valve body. Each valve shall be tested to five hundred (500) psi hydrostatic pressure. In any and all cases of conflict between these Specifications and AWWA C-509 or C-515, these Specifications shall govern but only to the extent of such conflict.
2. In addition to the requirements of the AWWA Standards, the valve shall meet the following Specification:

    a. Valve body, bonnet and rubber encapsulated gate shall be Ductile Iron conforming to ASTM A-536 or ASTM A-395 or Cast Iron conforming to ASTM A-126 Class B. Shell thickness of body and bonnet components shall conform to Table 2 Sec. 4.4 AWWA C-509. Stems shall be manganese bronze in accordance with ASTM B-132, having a minimum tensile strength of 60,000 psi. Bonnet bolts shall be stainless steel in accordance with ASTM A-193 Gr. B.8 304SS, ANSI B 18.2.1. Bonnet nuts shall be stainless steel in accordance with ASTM A 194 Gr. B.8 304SS, ANSI B18.2.2. Tapped holes with stud bolts are prohibited. Valves shall have a nonrising stem, two inch (2″) square operating nut, which shall turn right (clockwise) to open. Valves shall be furnished with mechanical joint ends (in accordance with AWWA C-111), complete with bolts, nuts, retainer glands and gaskets, unless flanged (in accordance with ANSI B16.1, Class 125) or other type ends are indicated on the plans. Retainer glands, lugs or grip rings will be required for new installations requiring retainers. Valves shall be vertical type unless otherwise approved, with double O-ring stem seals without gearing or bypass valves. O-ring seal plates shall be cast or ductile iron; seal plate bolts and nuts shall be 304 stainless steel ANSI B18.2.1. When both O rings are located above the thrust collar, the bearing area shall be fusion bonded epoxy coated, and contain a thermoplastic washer to reduce friction. When the thrust collar is located between two (2) "O" rings the entire space between the "O" rings shall be lubricated. Four inch (4″) to twelve inch (12″) valves shall have a maximum number of valve turns of three (3) diameters

plus three (3) turns. The maximum number of valve turns for larger valves, butterfly valves, shall be as given in the following table

TABLE I – VALVE TURNS

DIAMETER	MIN./ MAX. TURNS
16″ Vertical	50-51 (No Gearing)
16″ Horizontal	95-110 (Gearing)
20″ Vertical	62-63 (No Gearing)
20″ Horizontal	120-135 (Gearing)
24″ Vertical	95-155 (Gearing)
24″ Horizontal	95-155 (Gearing)

b Valve body and bonnet shall be coated on all exterior and interior surfaces with a fusion bonded epoxy conforming to the requirements of AWWA Standard for Protective Epoxy Interior Coatings for Valves and Hydrants; C-550. Painted surfaces and spray applied epoxy coatings are not acceptable. Manufacturer shall certify that the coating will conform to following sections of the Standard: a) Section 2, Materials. (Relating to the suitability of the coating for use in a potable water system).

c Section 4, Testing and Inspection. (Relating to qualification and production testing).

1) The valve shall be designed so that during operation, or cycling of the valve, there is no friction or abrasion or rubbing together of the gate and body that can wear away any rubber or epoxy and expose bare iron. Valve manufacturer shall provide evidence from an independent testing laboratory that its valve can operate through one thousand (1000) cycles or operation at two hundred fifty (250) psi unbalanced closing pressure and flow to open discharge without causing damage to the epoxy coating in body and gate and/or rubber coating on gate.
2) Gate shall be covered with rubber over all interior and exterior ferrous surfaces. The rubber shall be securely bonded to the gate body, including the part, which houses the stem nut. The stem hole through the gate shall be full opening top to bottom, and shall also be covered with rubber.
3) The upper "O" ring stem seal shall be replaceable with the valve under pressure in the full open position.
4) Resilient seated tapping valves shall be furnished with the tapping flange having a raised face or lip designed to engage the correspondence recess in the tapping sleeve flange in accordance with MSS-SP60. Tapping valves without the raised face on the tapping flange are not permitted since they do not assure the proper alignment requirement to prevent damage by a misaligned shell cutter. The interior of the waterway in the body shall be a full opening and capable of passing a full-sized shell cutter equal to the nominal diameter of the valve.
5) Valves shall be preapproved by the Department of Public Works, Bureau of Water and Wastewater, Utility Engineering Division.

J. Tapping Valves and Sleeves

1. Valves for tapping service shall meet all the requirements for gate valves. Tapping valves shall conform to Gate Valves 2, c, 4 above unless otherwise stated in the Contract Documents. All tapping sleeves shall be furnished with an outlet for testing, be iron body mechanical joint or stainless steel and must be preapproved by the City.
2. Before placing sleeve, clean existing pipe and check pipe outside diameter and ovalness to verify that sleeve will fit and be watertight. Install sleeve and valve. Keep closest edge of sleeve a minimum of nine inches (9″) from face of existing joint bell. Water test the assembly in accordance with manufacturer's instructions to ensure watertightness in the presence of the Engineer before tapping the existing pipe taps existing pipe.

K. Butterfly Valves: Thirty inch (30″) through seventy-two inch (72″)

1. Rubber seated butterfly valves shall be manufactured in accordance with AWWA C504 as modified herein. Valves shall be Class 250B, suitable for direct burial, and designed for a differential pressure across the valve of two hundred fifty (250) psi, and a minimum flow of fifteen feet (15′) per second for opening and closing. The rating shall be based on a design stress of three to one (3 to 1) on the yield strength or five to one (5 to 1) on a tensile strength of the materials used. Thirty inch (30″) to forty-eight inch (48″) valves shall be furnished with mechanical joint ends (conforming to AWWA C110/ANSI A21.11 and AWWA C-111) complete with bolts, nuts, retainer glands, lug and grip rings restraints and gaskets. A fifty-four inch (54″) to seventy-two inch (72″) valves shall be furnished with flanged joint ends (ANSI B16.1 Class 250), unless otherwise noted in the Contract Documents. Flanged joint ends shall be accompanied with flanged and plain end pieces assembled to the valve's flanged ends with bolts, nuts and gaskets. Each flanged and plain end piece shall have an overall laying length of not less than twelve inches (12″) nor more than eighteen inches (18″).
2. Disk: The Valve disc shall be designated and tested in accordance with AWWA C504.00. The valve disc shall be constructed of stainless steel ASTM A-296, Grade CF8M; cast iron ASTM A-48, Class 40 or ASTM A 436, Type I; or ductile iron ASTM A-536, Grade 65-45-12. The disc edge shall have a stainless steel; type 316 edges, sizes thirty inch (30″) through forty-eight inch (48″), and a minimum type 304, for sizes above fifty-four inch (54″), for mating with the rubber seat. Discs shall be of the flow through design with no internal cores or ribs transverse to the flow. Refer to the Department of Public Works Bureau of Water and Wastewater, Utility Engineering Division's approved list at the Water Engineering Office.
3. Seat: The valve seat shall be of a rubber compound complying with AWWA C504.00, Section 8. Valve seats shall be located in the valve body or on valve disk as specified in the Special Provisions. Valves employing snap rings, retaining rings or screws that penetrate the rubber will not be accepted. Seats shall be a full 360 degrees without interruption and have a plurality of grooves mating with a spherical disc edge seating surface. Valves thirty inch (30″) diameter and larger shall have adjustable seats of a design that permits replacement in the field without removal of the valve from the line.
4. Shaft: Shall be horizontal when the valve is installed in the water main. Valve shafts shall be stainless steel ASTM A-564, type 630, and condition H-1100. Stub shafts or through shafts are acceptable. The valve shaft/disc connection shall be

made through the use of on center taper pins. Taper pins shall be made of the same material as the shaft. The material shall be ASTM A-564, type 630, condition H-1100. Shafts seals shall be split V-type, self-adjusting. O-rings are not acceptable. Valves shall be supplied with one and one-quarter inch (1-1/4″) square or round extension shafts, in ten foot (10′) lengths, which are to be cut and assembled in the field installations.

5. Actuators: All actuators shall meet design requirements as specified in AWWA C504.00. Mechanical stops shall be provided in accordance with AWWA C504.00 maximum input load requirements and capable of adjustment for ninety degrees (90°) plus or minus five percent (± 5%) of valve travel. The valve actuator shall be suitable for buried service. The gearing shall be such as to locate the operating nut in the vertical position. All actuator gears shall be for quarter turn valve applications. The input shaft shall be stainless steel with bronze bushings at the out put drive sleeve and shall also be equipped with adjustable mechanical stops to prevent over travel of the valve disc in the open and closed position. A stop limiting device shall be provided in the input to the operators for open and closed position and all operator components between the input and these stops shall be designed to withstand without damage an input torque of three hundred (300) foot pounds. Gearing provided on the valves shall be such as to provide operation with an average eighty (80) foot pounds input torque at the operating nut. The valve operator shall be sized to operate the valve with the specified flow and pressure in either direction. Valve actuators may be worm gear or traveling nut type with a two inch (2″) square operating nut, which shall turn right (clockwise) to open. Actuators shall be fully enclosed in a gasketed grease filled enclosure suitable for direct burial. As approved by the Department of Public Works, Bureau of Water and Wastewater, Utility Engineering Division.
6. All butterfly valves shall be supplied with an over torque protector, which will indicate size of valve, direction to open and valve turn count. Refer to the Department of Public Works Bureau of Water and Wastewater, Utility Engineering Division's approved list at the Water Engineering Office.
7. Body: The valve body shall be constructed of cast iron ASTM A-126 Class B. Minimal body wall thickness shall be equal to that specified in AWWA Standard C504, Table 1 for Class 250B Gray Iron body material. Valves shall have "250" cast into the valve body casting. The entire valve body, both internal and external surfaces, except for the seating surface, shall be epoxy coated. The epoxy coating shall be a minimal of seven (7) mils nominal of NSF approved two (2) part epoxy.
8. Buried valves shall be furnished with an extension stem terminating twelve inches (12″) below finished grade in accordance with the Standard Details.

L. Air/Vacuum Release Valve

1. The air/vacuum valve shall be of the type that automatically releases to atmosphere large amounts of air found in pipelines during filling cycle and allows air into a line when it is being drained or when a vacuum occurs.
2. The air/vacuum valve shall have a cast iron body and cast iron cover. The internal compound lever mechanism shall be stainless steel and all other internals including float shall be stainless steel to avoid galvanic action. The stainless steel float shall withstand a minimum pressure of one thousand (1,000) psi.

3. All materials of construction shall be certified in writing to conform to ASTM Specifications as follows:

PART	MATERIAL	SPECIFICATION
Body and Cover	Cast Iron	ASTM A48, Class 30
Internal Linkage	Stainless Steel	Series 300
Float & Internals	Stainless Steel	Series 300 Seat Buna-N
Exterior Paint	Phenolic Primer	FDA approved for Red Oxide
	potable water	

4. All internals shall be easily removed through the top cover without removing the main valve from the lines.
5. An isolating valve shall be installed between force main and air/vacuum release valve for maintenance.
6. Air/Vacuum release valve shall be installed in an easily accessible vault. Vault shall be adequately vented to meet air/vacuum release valve requirement.
7. The valve manufacturer shall furnish installation and maintenance instruction manuals with each valve.

M. Screw Type Roadway Valve Boxes and Covers

1. Screw type roadway valve boxes and covers shall be made of gray iron conforming to the requirements of ASTM A48, Class 35B, as noted in section 3.1 of AASHTO M306 and shall meet the dimensional and marking requirements indicated on the Standard Details. The iron material used in products provided shall have a minimum recycled material content of seventy-five percent (75%). The recycled materials shall consist of post consumer material.
2. All casting manufacturers shall be approved suppliers of cast iron products to the Maryland Department of Transportation and City of Baltimore. All manufacturers shall be able to demonstrate that there is an acceptable quality control program at the producing foundry and upon request shall furnish a quality control manual. As part of the quality control program the producing foundry shall be made available for the purpose of conducting an audit prior to supplying casting. All valve box parts shall be manufactured at the same producing facility.
3. Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage, cracks and other surface defects. Castings shall be reasonably smooth and well cleaned by shot blasting. Surfaces of the castings shall be free from burned on sand and shall be reasonably smooth. Runners, risers, fins, and other cast on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between covers and top sections shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. As cast dimensions may vary within accepted foundry tolerances as outlined in the Iron Castings Handbook published by the American Foundrymen's Society, Inc. Nominally, casting dimensional tolerances shall be plus or minus one-sixteenth of an inch (±1/16″) per foot. All published casting weights are average and approximate values and shall vary plus or minus five percent (±5%). Casting dimensions and specific tolerances are identified on the associated casting drawings. Castings shall meet the meet weight and dimensional

criteria as shown on the associated drawings. All castings shall fit together properly and be fully interchangeable.

4. All gray iron valve boxes shall be rated for traffic service.
5. Inspections shall be in accordance with 9.1.2 of AASHTO M306. Results of these tests shall be furnished to the purchaser upon request. The heat or production date and product numbers, as cast on the casting shall be the basis of traceability and recording of the tests.
6. A foundry certification shall be furnished to the purchaser stating that each lot meets the requirements of this Specification. Applicable documentation shall be made available to the purchaser upon request.
7. Each casting shall be identifiable and show, at a minimum, the following: name of the producing foundry, country of manufacture (such as "Made in USA"), ASTM A48, CL 35B, individual part number, cast or heat date. All castings shall be marked in accordance with all applicable laws and/or regulations. Castings shall include all lettering as shown on the Specification Drawings.
8. The purchaser may conduct random checks on the castings. These random checks shall be conducted in accordance with AASHTO M306, Section 6.0 guidelines.
9. Refer to the Department of Public Works Bureau of Water and Wastewater, Utility Engineering Division's at the Water Engineering Office for the list of approved suppliers of cast iron roadway boxes.

N. Miscellaneous Small Pipe and Appurtenances

When indicated on the Standard Details or the Plans, the following materials shall meet the material requirements of the referenced Standards or Specifications:

a. Galvanized steel pipe, ASTM A 120, Schedule 40.
b. Standard malleable iron fittings, galvanized, ASTM A 153, A 197.
c. Brass pipe, ASTM B 43.
d. Bronze gate valves, FSS WW-V-54c.

O. Valve extension stems shall be one and one-quarter inch (1-1/4″) square or round, of cold rolled steel and furnished with a two inch (2″) square nut.

PART 3 EXECUTION

A. General

1. Excavation, foundation preparation, backfill, and compaction shall be as specified in 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill).
2. Construction methods shall be in accordance with 33 11 13 (Public Water Utility Distribution Piping).
3. Valves shall be restrained, supported, and strapped to tees, crosses, dead ends, stubs, or outlets in accordance with the Standard Details.

B. Buried Gate and Butterfly Valves

1. Buried gate and butterfly valves shall be installed in accordance with the Standard Details and at the locations shown on the Plans or as directed by the Engineer. Unless otherwise shown on the Plans, all gate valves sixteen inch (16″) diameter

and smaller and all butterfly valves shall be supported as shown in the Standard Details, and shall be installed with an adjustable roadway valve box.

2. Roadway valve boxes shall be set at right angles to the water main, centered and plumb over the valve operating nut. Backfill shall be compacted under and around valve boxes to insure that no vertical loads are transmitted to the valve operators. Valves box sections shall overlap a minimum of six inches (6″).

C. Valves in Vaults or Manholes

Dewatering and air release and vacuum valves shall be installed in manholes or vaults in accordance with the Standard Details and/or Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

Unit of measure will be each. Payment for Gate/Butterfly Valve, Air/Vacuum Release Valve, Tapping Sleeve/Valve and manhole/vault will be made at Contract Unit Price per each, which price and payment will include flanged and mechanical joint ends, flanged and plain end pieces where needed along with sleeve couplings, tapping machine connection, saddle, excavation and backfill beyond trench excavation pay limits, concrete base, riser sections, castings and all labor, materials, tools, equipment and incidentals needed to complete Work specified.

33 12 19 WATER UTILITY DISTRIBUTION FIRE HYDRANTS

PART 1 GENERAL

1.1 DESCRIPTION

Work consists of furnishing and setting fire hydrants, (boot with ductile iron retainer gland, standpipe and hydrant complete) plus constructing dry wells complete, at locations indicated in the Contract documents or as directed. Work includes restoration of landscape features and sodding. Trench excavation and backfill for hydrant connecting pipe, restraint, water valve and water valve casing are not part of Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hydrants: Fire hydrants shall be compression type, hand operated, for fire protection service under a minimum operating pressure of two hundred (200) psig manufactured per AWWA C502.

1. All fire hydrants furnished shall be tested to four hundred (400) psig operating pressure.
2. The manufacturer shall be regularly engaged in the design, manufacture and maintenance of fire hydrants. The manufacturer must furnish satisfactory evidence of adequate facilities for furnishing repair parts for hydrants furnished.
3. Hydrant Models—as preapproved by the Water and Wastewater Engineering Division.
4. AWWA C502 is modified or supplemented as follows:

a. The basic design shall be the dry top type, which prevents the operating threads from coming in contact with the water service. It shall be of the compression type, opening against the pressure and closing with the pressure.

b. The operating threads shall be contained in the opening chamber sealed at the top and bottom with an "O-Ring" seal. The chamber shall contain a lubricating grease or oil. The operating nut shall be one (1) piece brass or bronze.

c. Main valve opening of the hydrant shall be not less than five and one-quarter inch (5-1/4″) for a three (3) way hydrant.

d. Main valve seat shall be made of bronze and threaded into a bronze bushing in the hydrant base to preclude galvanic corrosion between dissimilar metals. The upper valve plate shall also be made of bronze (see ASTM B 584).

e. A stop limiting device shall be incorporated in the operating head only if a positive stop is not located in the interior of the shoe casing.

f. There shall be a minimum of two (2) bronze drains and two (2) bronze drain outlets located at least ninty degrees (90°) apart. When the hydrant is pressurized and in the closed position, it shall drain through the two (2) drains and outlets at the following rate:

Q = 1.29*SQR(P), where Q = gpm, P = psi, and SQR = square root

g. The hydrant shall be so designed to permit the removal of all the working parts along with the main valve and drain valve facings from the hydrant up through the barrel without disturbing the earth around the hydrant section; the removal of the seat ring shall be accomplished with the use of a thirty inch (30") maximum length seat removal key

h. Hydrant barrel shall be a traffic model made in two (2) sections with the flange or adjusting feature located approximately two inches (2″) above the ground line. The main valve stem shall be made in two (2) sections with a breakable coupling. There shall be a minimum of eight (8) nuts and bolts connecting the upper barrel and the lower barrel, at the traffic/safety flange. The fire hydrant must be installed as shown on the Baltimore City Standard Details.

i. The operating nut, hydrant nozzles, direction of opening and painting shall be in keeping with those hydrants already in the system. The size of the pentagon nut shall be one and seven-sixteenths of an inch (1-7/16″), point to flat. The height of the nut shall not be less than one inch (1″).

j. Outlet Nozzles: Two (2), two and one-half inch (2-1/2″) nominal I.D. hose nozzles; one (1), four inch (4") nominal I.D. steamer or pumper connection. Threads for two and one-half inch (2-1/2″) nozzles per National Fire Standard Hose Coupling Screw Threads; threads for four inch (4″) steamer or pumper connection shall be as specified for Baltimore City (latest revision 1/15/75), Drawing No. W-115 H-37242.

k. All lower standpipes shall be made of ductile iron or ASTM A-126 gray iron.

l. The interior of the shoe casing and all lower main valve components shall be. Protected with an epoxy coating that is in full compliance with AWWA C-550.

m. Painting: Above grade line, outside of hydrant shall be painted with two (2) coats of zinc chromate primer and two (2) finish coats of a bright or safety Orange enamel.

n. Manufacture's origin shall be cast into the bonnet or upper barrel of the fire hydrant.

o. All hydrants shall be shop tested in accordance with AWWA Specification C-502.

p. Bury Length four and one-half foot (4-1/2') or at a height that will require no fire hydrant extensions and meets the required height stated above, unless directed differently by the Engineer

q. Between elbow and top cap, the barrel shall be made in two (2) parts connected by a swivel segment to permit facing the nozzles in any direction. Bonnet shall be bolted to the standpipe and shall have cast on the top an arrow and the word "Open" indicating the direction for opening.

r. Hydrant Top: Hydrants shall be permanently lubricated and require one (1) man maintenance, no special tools.

s. Direction of operating nut rotation to open: Left (counterclockwise).

t. Gaskets and "O"-rings: Material shall be rubber composition; asbestos prohibited.

u. Hydrant Inlet: Boot side inlet shall be six inch (6″) mechanical joint with accessories (glands, plain rubber gaskets, bolts and nuts, restrained lug or grip ring).

v. Cap chains: Hose cap chains and steamer cap chains are required with all hydrants; chain links (zinc plated steel) shall be fabricated not less than one-eighth inch (1/8″) in diameter and with S hook device (zinc plated steel) attached.

B. Gravel or crushed stone for hydrant foundation shall meet the gradation requirements of AASHTO M-43 No. 67.

C. Retainer glands, lugs or grip rings and appurtenances for fire hydrant restraint, and pipe caps and plugs for existing fire hydrant lead abandonment shall be as specified in 33 11 13 (Public Water Utility Distribution Piping).

D. Portland cement concrete for hydrant and cap blocking shall be Mix No. 1 as specified 03 30 00 Part 2.1 G (Portland Cement Concrete Structures).

PART 3 EXECUTION

3.1 GENERAL

A. Excavation, foundation preparation, backfill, and compaction shall be as specified in 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill).

B. All related Work on hydrant water line including tests and chlorination shall be per applicable provisions of 33 11 13 (Public Water Utility Distribution Piping).

3.2 FIRE HYDRANT INSTALLATION

A. Shall be in compliance with AWWA Manuel M17)

B. Fire hydrants shall be installed and restrained in accordance with the Baltimore City Standard Details, at the locations shown, and to elevations directed by the Engineer. Hydrants shall be set within a gravel or crushed stone drainage well extending the full width of the trench.

C. Hydrant leads shall be laid level on a firm foundation to insure that the hydrant is set plumb. Backfill around the hydrant shall be compacted so as to obtain a density of at least 95% of maximum when measured in accordance with AASHTO T180, Method D.

D. Where hydrants are to be relocated, the Contractor shall remove the existing tee, tapping sleeve, valve and fire hydrant and sleeve up the main water line.

E. A gravel well one foot (1′) square by two feet (2′) deep shall be constructed adjacent to the fire hydrant connection trench. Gravel should be placed at least one foot (1′) above connection at shoe and lower barrel, as shown on the Standard Details.

F. Any items disturbed during construction, including shrubs and lawns, shall be restored by the Contractor upon completion of Work. Grassed areas shall be resodded or seeded and mulched as part of Work per 32 92 23 (Turf Establishment), or the Contract Documents.

G. Install traffic hydrants with a concrete collar, about six inches (6″) thick two feet (2′) by two feet (2′) around the lower fire hydrant barrel at or near the ground line. Expansion material should be placed between the fire hydrant barrel and the concrete collar.

PART 4 MEASUREMENT AND PAYMENT

A. Unit of measure will be each. Payment for Fire Hydrants will be made at the Contract Unit Price per each, which price and payment will include property restoration and sodding, seeding and mulching and all labor, materials, tools, equipment and incidentals needed to excavate, backfill, removal and disposal of unsuitable material, blocking, gravel well, copper pipe or tubing needed to complete Work specified.

B. The installation of a hydrant connection pipe, a gate valve and a water valve casing will be paid under other pay items.

C. Pavement restoration shall be measured and paid for in accordance with 32 01 30.10 (Patch Existing Pavement and Reset Utility Services).

33 13 00 CLEANING AND LINING WATER MAINS

PART 1 GENERAL

1.1 DESCRIPTION

The Work to be done under the cleaning and lining portion of the Contract shall consist of furnishing all labor, materials, and equipment for the cleaning and cement mortar lining of existing water mains of various sizes and the temporary bypass associated with the Work as indicated in accordance with the Contract Documents.

1.2 QUALITY ASSURANCE:

Quality assurance for pipe, fittings, valves and couplings furnished by the Contractor shall meet requirements of Section 33 11 13 (Public Water Utility Distribution Piping) and shall be in accordance with the latest editions of national standards as specified or as modified herein.

1.3 CLEANING AND LINING

A. The Contractor shall guarantee to restore all cleaned and cement mortar lined water mains to the following minimum Hazen-Williams "C" Factor (C_{hw}) based on nominal pipe diameters with proper allowance being made for bends and fittings in accordance with accepted practice.

Nominal Pipe Diameter	Guaranteed Hazen-Williams C_{hw} Factor
4 inch	105
6 inch	105
8 inch	110
10 inch	115
12 inch	120
14 inch	125
16 inch	125
20 inch	125
Above 20 inch	130

B. Thickness of the cement mortar lining shall be uniform and meet requirements of AWWA C602.

1.4 JOB CONDITIONS

A. Provide temporary bypass water service piping of adequate size to maintain water service and fire protection to abutting properties at all times.

B. Unless otherwise directed by the Engineer, during stormy or inclement weather, no Work will be done except that which is incidental to cleaning and lining operation from November 15 through March 15. Work, which requires temporary service piping, will not be performed.

PART 2 PRODUCTS

2.1 MATERIALS

A. Materials furnished by the Contractor shall include but are not limited to the following:

1. Pipe, fittings, valves of any diameter, and jointing, including restraints as necessary, Corporation stops and couplings for taps and coating materials for permanent installation per requirements of Section 33 00 02 (Corrosion Control) and 33 11 13 (Public Water Utility Distribution Piping).

   a. Mechanical and/or push on joints gray iron or ductile iron pipe and fittings and the following appurtenances thereto:

      1) Glands, gaskets, nuts and bolts for mechanical joints.
      2) Gaskets and lubricants for push on joints.

   b. Fire hydrants and the following appurtenances thereto:

1) Six inch (6″) diameter pipe connection or as shown on the Contract Drawings.
2) Fire hydrant restraint appurtenances except three-quarter inch (3/4″) threaded bars, bolts and nuts.

c. Mechanical joint valves including valve casings therefore and reducers when required to install valves.
d. Manhole and vault frames and covers.
e. Valves.
f. Backflow preventers for temporary piping.
g. Corporation stops and couplings for taps.
h. Notched meter covers for temporary use when temporary piping is in service.

2. The Contractor shall provide temporary bypass and fire hydrant piping to maintain water service and fire protection as shown on the Contract Drawings. Such piping shall be of a material that will withstand the working pressure at the location without leakage. Bypass pipe and fittings shall not impart objectionable color, taste or odor to the water being supplied and shall meet National Sanitary Foundation (NSF) requirements for potable water. Plastic pipe and hose shall be approved for potable water by NSF and bear the approval stamp "NSF-PW."

B. Cleaning and Lining

1. Materials

a. Materials for lining shall be in accordance with requirements of AWWA C602 except as modified herein:

1) In addition to AWWA C602, sand shall conform to requirements of ASTM C144 and shall be kept clean and free of foreign materials during transportation and storage on the site. Sand shall be cleaned and well graded, having clean, hard, durable, uncoated grains, free from organic matter, shale, clay lumps, coal, soft or flaky particles and other unsound or deleterious substances. If required, all sand shall be washed and shall be rescreened to eliminate oversize material thoroughly dried and shall be passed through a #16 mesh screen. Not more than fifteen percent (15%) in weight shall pass a No. 100 sieve. Field mixing of sand will not be permitted.
2) Cement shall be Type I or II meeting the requirements of the latest ASTM C150, shipped to the Contract site in full sacks and stored so it is kept dry. Broken sacks of cement shall not be used for lining operations. Cement shall be manufactured at facilities that have been certified by the National Sanitation Foundation for compliance with ANSI/NSF Standard 61, Drinking Water System Components. Sacks of cement shall bear the associated NSF approval stamp.
3) Proportions of cement and sand in the mortar shall be one (1) part cement to one and one-half (1.5) parts sand per AWWA C602.
4) Water shall be clean and free from injurious ingredients. Both the cement and the sand shall receive a secondary screening after delivery if deemed advisable by the Engineer. The water/cement ratio shall be carefully controlled and kept to a minimum.

5) The mortar shall be mixed by an approved type of machine for not less than three (3) minutes and for a longer time if necessary to obtain maximum plasticity. The mortar shall be used promptly after mixing, and in no case may mortar, which has attained its initial set, be used.

2. Equipment

a. Cleaning equipment shall be drag and cable or cable hydraulic type. Knocker type will not be allowed.

b. Equipment for placing cement mortar lining shall have the following characteristics:

1) An applicator head that will, in one (1) course, centrifugally project the mortar against the surface of all pipe sections and long radius bends, without injurious rebound, and with sufficient velocity to cause the mortar to be densely packed and to adhere in place. The rate of travel of the machine and the rate of discharge of mortar against the wall of the pipe shall be entirely mechanically controlled so as to produce a smooth, uniform thickness of lining throughout the interior of the pipe.

2) An attachment with rotating or drag steel trowels that will follow the applicator head and trowel the cement mortar lining to a smooth, hard surface of uniform thickness. Operation of the trowels shall be continuous during the application of cement mortar and forward movement of the applicator head.

3) The machine shall move ahead of the lining so that nothing will come in contact with the toweled surface until it has attained its final set. Control of the forward movement of the machine and the mechanical placing of the mortar shall be provided to assure a uniform thickness of mortar lining as specified in AWWA C602.

PART 3 EXECUTION

3.1 PROPERTY OWNERS NOTIFICATION

A. Notify all property owners adjacent to the Work in advance of the Work.

B. There shall be two types of notices:

1. One for property owners whose water service will be temporarily interrupted while their service connections are being connected and disconnected from temporary bypass piping.

2. It shall be the Contractor's responsibility through the Engineer, to notify in writing all consumers placed on bypass piping and provide them with an emergency phone number and contact person in case of bypass emergencies. The information shall direct the consumer to flush their in house plumbing by running water and temporarily removing aerators, after they are returned to regular service. This information shall be distributed at least three (3), but not more than seven (7) working days, in advance of placing the consumers on bypass piping.

3. The Contractor shall provide the Engineer with a letter stating when and where notifications were delivered, as described in the Special Provisions.

3.2 TEMPORARY BYPASS WATER SERVICE SYSTEM

A. Before section of water main to be cleaned and lined will be shutdown, the Contractor shall provide and maintain a temporary bypass piping system of adequate size to provide water service and fire protection to abutting properties as required herein and as directed by the Engineer.

B. The Work covered, shall consist of furnishing all materials, labor and equipment and performing all operations in connection with temporary services in strict accordance with this section of the Specifications and the applicable Drawings, also to AWWA Standard C 602 89 unless contradicted by these Specifications.

C. The general Work shall consist of, but is not limited to the following: Temporary bypass piping, temporary hydrant connections and disconnections, temporary house service connections, and temporary connection to existing main, bypass valves and temporary pressure reducing valves.

D. The Contractor shall furnish, install, and maintain all bypass pipe and other appurtenances for consumers deprived of water during the cleaning and lining operations. Connections and disconnections of temporary bypass to consumer's services and all back clearing shall be done by the Contractor. The Contractor shall have a maintenance crew on standby ready to respond to emergencies, such as: a broken bypass pipe, a broken temporary fire hydrant, etc. The crew shall be available on a twenty-four (24) hour basis and the Contractor must furnish the Engineer with the address and phone number of the contact person for this purpose, a telephone answering machine is not acceptable. It shall be the Contractor's responsibility, through the Engineer, to notify in writing all consumers placed on bypass piping and provide them with an emergency phone number and contact person in case of bypass emergencies. The information shall direct the consumer to flush their in house plumbing by running water and temporarily removing aerators, after they are returned to regular service. This information shall be distributed at least three (3) days, but not more than seven (7) working days, in advance of placing the consumers on bypass piping. The Contractor shall provide the Engineer with a letter stating when and where notifications were delivered.

E. The layout of the temporary bypass piping must be approved by the Engineer prior to allowing the Contractor to charge the piping for testing purposes. The City maintains the right to have the Contractor relocate any unacceptable layout at Contractor's expense.

F. It should be noted before estimating the materials required for bypass piping that all City water consumers who will be affected by the Cleaning and Lining operation in the area, have been included on the Contract Plans.

G. The service and meter locations shown on the Contract Drawings are only schematic and shall be verified by the Contractor.

H. It will be the total responsibility of the Contractor to store all consumers' water meters in a safe and secure place. The City will not assume any liability for damage or theft to water

meters that have been removed by the Contractor and left at the job site. All meters must be tagged for proper identification as directed by the Engineer.

I. The hoses and other materials, which are to be used, shall be clean, sanitary, watertight, and adequate to withstand the existing pressures, and shall be installed in such a manner as to produce a minimum hazard and inconvenience to the consumer and to the public. The Bypass pipe and fittings shall be disinfected prior to being put into service. Additional isolation valves may be placed in the bypass piping, as directed by the Engineer.

J. All dwellings, shops, places of business and construction sites served by the mains to be lined, whether occupied at the time or not, shall be provided with temporary hose service connections.

K. The Contractor will be required to install temporary locking meter covers, with hole knockouts for bypass piping, for all services placed on bypass piping. The covers must be equal in design and have the same size locking nut as Baltimore City current standard meter covers.

L. Where there are no outside meters or hose bib connections, the Contractor shall pass a hose line through an existing basement window, with written homeowner's approval, in such a fashion that will leave the home adequately secure. In the event the Contractor is unable to notify for a temporary hookup, it shall leave a message explaining the purpose of the cleaning and lining project, and indicating phone numbers that will connect them to personnel that will install the temporary lines promptly.

M. The Contractor shall maintain the temporary water service lines in safe and operative condition at all times and shall be responsible for the protection of life, property and the prevention of injury to persons and structures. Safeguards shall be provided by the Contractor to the satisfaction of the Engineer, but such provisions shall not relieve the Contractor of full responsibility for the adequacy of protection. Any temporary bypass lines or services crossing a sidewalk or roadway shall be temporarily covered with bituminous cold patch. Lines four inch (4″) in size and larger crossing roadways shall be lowered to a depth such that the top of the bypass in the trench is only two inches (2″) above the surface.

N. Water for temporary bypass service shall be taken from the nearest available fire hydrant or as shown on the Drawings. When required and with the approval of the Engineer, make below ground taps where fire hydrants cannot be used. Furnish and install back-flow preventers on temporary bypass piping where directed by the Engineer. Make temporary bypass service attachments to fire hydrants in a manner that will permit removal, if required, so fire hydrants may be used for fire fighting purposes with a minimum of effort. All piping fittings, valves, caps and ductile iron pipe for the underground feeds are to be installed prior to laying any temporary bypass piping.

O. When the Contractor must obtain water or supply water for temporary service from below ground feed installations, the main shall be excavated behind the sideline valve, or at a location directed by the Engineer or as shown on the Contract Drawings. A tee/valve with a sleeve and spacer shall be cut in to provide a connection for the bypass. The Contractor shall provide a plug on the run of the tee and a blank flange on the existing water main, with blocking between to secure the temporary feed in place. The bypass piping shall be attached in accordance with the details shown in the Contract Drawings.

P. Provide each dwelling, shop, place of business and building served by the main to be lined, whether occupied at the time or not, with a temporary service connection. Connect temporary service by removing outside meter and making temporary connection to existing house connection, connect to house hose bib, as directed by the Engineer. A valve "Y" is mandatory to allow use of house hose bibs. Before removing meter, give the Engineer forty-eight (48) hours notice. Contractor shall not handle meters unless Engineer is present. Meters shall be capped at both ends when not in use and hung inside the meter pit to prevent damage, switching and misplacement. Provide protection for meters and meter covers at all times. Meter covers, which are ajar in sidewalks or public rights of way shall be protected with flashing barricades.

Q. Where the Contractor must connect the domestic service to the bypass piping by crossing the road, the service lead must be sized at least equal to the existing service lead but never smaller. The service lead must be secured in place to allow passage of vehicular traffic. However, in no case will rubber hose be accepted for this type of installation of crossing the road. In areas where hot mix asphalt is used to cover temporary bypass piping on top of existing paving; a material shall be used that will effectively inhibit the bonding of the hot mix asphalt to the existing paving, will not stain or otherwise cause discoloration, and will not adversely effect the quality of the materials.

R. Unless otherwise indicated in these Contract Documents or directed by the Engineer, the Contractor will be restricted to confine its Work activities to the width of the existing roadway surface or the existing width of roadway from the curb to curb. All bypass piping must be installed at the edge of the roadways, with proper caution signs, or against the existing curbs. No storage of any type equipment or materials will be permitted at any time beyond the existing curb lines or edge of existing roadway. The existing width for all roadways are shown on the Contract Plans and must be strictly adhered to at all times.

S. The pipe and other materials, which are to be furnished by the Contractor for use as temporary service pipe, shall be clean, watertight and fully adequate to withstand existing pressures and all other conditions of use and shall be approved by the Engineer.

T. Place temporary bypass piping system so as not to interfere with vehicular and pedestrian traffic and the general public. Do not place during freezing weather. If already installed, protect from freezing. Sections of temporary bypass lines that cross roadways or driveways shall be covered with a bituminous cold patch. Protection of concrete driveways shall be provided to prevent discoloration from the bituminous material. Bypass lines at street crossings, sized four inches (4″) in diameter and larger, shall be placed below the existing road grade. Sections of bypass or services that cross sidewalks shall be adequately protected at all times with barricades, ramps and fluorescent paint. Cold patch, with sidewalk discoloration protection, may be used in lieu of barricades. Crossings of all bypass lines that are parallel to sidewalks and crossing perpendicular to handicap ramps shall be placed below the existing road grade.

U. When installed in a "major roadway" ingress or egress to retail and commercial property, handicap ramps, or when so directed by the Engineer, the Contractor shall bury any bypass piping to a full depth and cover with a "special temporary paving" as described in the Special Provisions. All bypass piping installed in roadways and/or ingress or egress to retail and commercial property shall be steel. All eight inch (8″) bypasses must be steel and shall be buried to a full depth no matter where it is being installed unless otherwise directed by the Engineer.

V. If during any stage of the Contract Work, the Contractor finds it necessary to use water from a service, or run a house to house connection, the Engineer shall be contacted to arrange to have the meters replaced with straight pipe. Caution shall be used to prevent meters from being switched and meter settings from being damaged. The Engineer shall be notified at least twenty-four (24) hours in advance for installation of temporary connections, and forty-eight (48) hours in advance for removal. The Engineer shall be notified whenever additional bypass services are made and whenever problems develop with any meters or services.

W. Temporary bypass piping for service connections three inch (3″) and larger diameter and for temporary fire protection shall be a minimum of four inch (4″) diameter.

X. The Contractor in accordance with AWWA C651 shall chlorinate temporary bypass piping including temporary house services. Contractor will take and have water samples analyzed by a certified laboratory. After the City approves samples, the Contractor shall place piping in service with as little disruption to consumers as is practical.

Y. The pipe and fittings shall provide adequate water tightness and care shall be exercised throughout the installation of any temporary pipe and service fittings to avoid any possible pollution of any City mains or house services, or contamination of the temporary pipe itself. During freezing, stormy, or inclement weather, no Work shall be done except that which is incidental to cleaning or lining, unless otherwise directed by the Engineer. No bypass pipe or service connections shall be installed during freezing weather and such pipe already in use shall be removed or drained. Accordingly, all bypass piping must be removed by November 15 and cannot be installed and charged prior to March 15.

Z. Upon restoration to service of water mains after being cleaned and lined, the Contractor shall remove the below ground feed connections, tee, blind flanges and corresponding sections of temporary bypass piping. The Contractor shall reconnect the main and leave the area in a neat and orderly condition and in every respect equal to their original condition.

3.3 TEMPORARY FIRE HYDRANT SERVICE

A. The Contractor shall furnish, install, maintain and remove the temporary fire hydrants with individual control valves as shown on the plans. Unless otherwise indicated on the plans, the temporary fire hydrants shall be placed adjacent to existing hydrants.

B. The temporary hydrants supplied shall be compatible with the Baltimore City Fire Department hose connections.

C. Temporary bypass piping for service connections for temporary fire protection shall be a minimum of four inch (4″) diameter.

D. Any cost involved for furnishing and maintaining the required number of temporary fire hydrants shall be included in the Contract Bid item price. All temporary fire hydrants should be installed as close as possible to an existing fire hydrant unless otherwise shown on the contact plans.

3.4 ACCESS AND EXCAVATED OPENINGS

A. Excavate and provide access at locations required facilitating the Work as required herein and as approved by the Engineer.

1. Excavate, provide sheeting and shoring, dewater and backfill in accordance with Section 31 23 16.16, (Structure Excavation) and 31 23 33 (Trenching and Backfilling, Point Excavation and Backfill).
2. Make access openings in pipe with ample space to admit and withdraw equipment with the least delay and without causing damage to existing pipe.
3. After City completes shutdown, the Contractor shall dewater pipeline and drain low spots. Provide measures, as required, to prevent water from entering the Work sections and maintain in a dry condition.
4. Remove pipe at access points by cutting with power operated pipe cutting machines, capable of making fast, true and smooth cuts so valves or the pipe sections removed may be replaced in true alignment. Where difficulties due to obstructions make it impossible to use preceding method of cutting pipe, other methods may be used provided the same results are attained and with no additional cost to the City.
5. Measure the outside diameter of all cut pipes. The outside diameter of pipe will determine the proper sized sleeves and/or couplings to be used in connecting new pipe to the cleaned and lined pipe or to existing pipe not to be cleaned and lined. Oversized couplings with adapter gaskets for smaller pipe are not acceptable. Exposed lead or poured joints shall be replaced with mechanical joint fittings or couplings as directed.

3.5 CLEANING AND LINING

A. Perform cleaning and lining in accordance with requirements of AWWA C602 as supplemented herein.

1. Cleaning

a. Clean the interior surfaces of the pipe and fittings to be lined by water propelled cleaning machine or other approved method, where practicable, and by hand where access by machine is not possible. Clean the interior of all pipe and fittings to be lined. Remove loose scale, rust, tuberculation, oil, grease, remains of old coating materials and accumulations of debris and all other foreign materials. Remove accumulations of water on the bottom of the interior of the pipe.
b. The Contractor shall provide including disposal of water used for cleaning existing water main all other materials and equipment and services.
c. Handle cleaning water in closed discharge hoses to prevent water and residue from causing damage. Dispose of solid laden water through a desilting filter box into a sanitary or combined sewer.
d. The Contractor shall pass the cleaning machine through the lines as many times as may be necessary in order to clean the existing water main to the satisfaction of the Engineer.
e. The cleaned surface shall be treated as may be necessary to insure a successful application of the cement/mortar lining. Oil and grease shall be removed by an approved volatile solvent.

f. If the Contractor causes damage to the existing water mains in any way, it will be responsible to repair or replace said main at its own expense with no additional compensation of time and cost.

g. The water required for hydraulic cleaning will be furnished by the City with charge to the Contractor in such quantities and at such pressures as are available through existing connections. In the event that the pressure or quantities are insufficient for hydraulically cleaning the main, the Contractor shall provide at its own cost and expense suitable equipment to provide water required for hydraulic cleaning. The City reserves the right to disallow hydraulic cleaning at its own discretion.

h. Catch basins, formed with sand bags, enlarged pits, or other approved methods shall be provided to control the flow of debris and wash water. Precautions shall be taken to prevent flooding of property by water and to prevent debris from entering storm drain inlets. Also, see City Standard BC 330.01.

i. The Contractor shall clean back all service connections; and should services, consumers' meters, or the consumers' service pipe between the meter and the building be restricted due to plugging of corporation stops or entrance of loosened foreign materials, it shall be the Contractor's responsibility, at no additional cost to the City, to remove such obstructions.

j. The Contractor shall take precautions to prevent obstruction of any lateral, hydrant, or service connection by deposit of cleaning debris, and shall flush all laterals, etc. It will be required to restore such connections to normal service condition at its own expense.

k. Following the cleaning operation and before placing cement/mortar lining, the City may examine the pipe for any deep pitting and other defects, and for leakage. In the event of discovery of any such defects, the City reserves the rights to suspend all cleaning operations until all necessary repairs are made. The Contractor will be granted an extension of time equal to the delay caused thereby, but it will not be allowed any additional compensation for any losses or damages sustained or alleged to have been sustained as a result of such delays.

2. Lining

a. Place lining with machines in one (1) course as specified herein. The cement mortar lining shall be continuous, dense, smooth, and without variation in quality and free from noticeable changes in thickness.

b. The lining shall be placed by a machine capable of projecting the mortar against the wall of the pipe at a high velocity. The impelling force shall be centrifugal and no air shall be utilized in the process of mixing or application. The machine shall be so devised, that the applied mortar shall receive a smooth surface finished by mechanical trowelling; the machine shall precede the lining surface until it has attained its initial set. Only such machines as have successfully placed cement linings similar to that specified and have proved satisfactory for this service for at least two (2) years shall be used.

c. Perform cement mortar lining of sharp bends, specials and areas closely adjacent to valves or other points where machine access is impossible or impractical, and the correcting of defective areas by hand. Place cement mortar lining so as not to seal or otherwise reduce the effectiveness of the

existing air valves and blow offs. Hand mortar Work shall be equal in appearance to machine placed Work and the same materials shall be used. If necessary, moisten prior to placement of mortar. Use steel trowels except where curvature of bends prohibit their use. Complete handwork in a section of the pipeline within twenty-four (24) hours after the machine Work in that section is complete. Feather edges between newly lined areas and unlined areas.

d. Clean and line mains up to side valves where shown on Drawings. Remove cleaning debris and lining material from existing house service connected to the lined main.

e. The lining shall be applied to all removed sections of cast iron pipe either while they are removed from the line, or after they are replaced provided that the pipe if lined, can be put into the line without damage to the lining.

3.6 CURING

A. Immediately upon the completion of the lining of a section of pipe between manholes or other openings, or at the end of one (1) day's run of the machine, the section of pipe shall be closed at each end and all openings covered to prevent circulation of air.

B. As soon as practicable after placing the lining, water shall be introduced into the sections between bulkheads in order to create a moist atmosphere to keep the lining damp.

C. The City will fill sections between gate valves with water as soon as possible, as heretofore provided.

D. Pipe lining shall cure for a minimum of seventy-two (72) hours before the Contractor proceeds with chlorination.

3.7. PROTECTION OF LINING

A. Every precaution shall be taken to prevent injury to the lining.

B. Should it be damaged by fault of the Contractor, or should it reveal evidence of defective Work or materials any time previous to the final acceptance of the Work, such damages or defective portions shall be removed at no expense to the City and shall be replaced by the Contractor to the satisfaction of the Engineer.

C. The Contractor shall protect any portion of the line subject to freezing by a covering of straw or earth, or other material.

D. The intent of the above Specifications is to assure a continuous, dense, homogeneous, and smooth lining which will protect the interior surfaces of the pipe to which it is applied.

3.8. CHLORINATION

A. Before chlorinating newly lined water main section the Contractor shall do the following:

1. Replace sections of pipe removed for access or installation of valves with new ductile iron pipe as directed by the Engineer.
2. Install fittings and provide mechanical couplings as required so no leakage is visible.

3. Recoat scarred exterior surfaces of the pipe and fittings, and coat the entire exterior surface of the mechanical couplings including bolts and nuts with mastic that is totally resistant to aliphatic hydrocarbons, such as Royston Roskote mastic A51 Plus or an approved equal.

3.9 CHLORINATION OF WATER MAIN

A. Upon completion of all cleaning and lining operations in a section of piping line and after the Work has been approved by the Engineer, the Contractor shall chlorinate the interior of the completed section in accordance with the 33 11 00, 1.4, E and F, (Public Water Utility Distribution Piping).

B. The Contractor shall furnish all materials, equipment, labor and chlorine for carrying out the disinfection procedure.

C. Due to environmental considerations the accepted level of chlorine shall not exceed five hundred (500) parts per million at the end of a twenty-four (24) hour contact period.

D. No chlorination and/or testing against in-service valves or mains will be allowed.

E. Every effort shall be made to flush all mains, services and fire hydrants prior to reconnecting.

F. Flush each fire hydrant individually. It may be necessary to disassemble the fire hydrant to remove debris that may have lodged and plugged it.

3.10 RETURNING LINED MAIN TO SERVICE

A. When chlorination has been completed and line is approved for service the Engineer will notify the Contractor to restore the line to service. The Contractor shall return the lined main section to service and perform the following:

B.

1. Backfill excavated areas. Operate all valves to return the cleaned and lined mains to service under the Engineer's supervision.
2. New service pipe and meters shall be installed where required in accordance with Section 33 12 00 (Water Services Water Meter Settings and Vaults). Reactivate house connections and remove temporary bypass piping system.

C. After permanent service is restored and temporary bypass piping is removed, restore disturbed areas and leave streets, sidewalks and adjacent properties in a neat and orderly condition as near as practical to the condition that existed prior to being disturbed.

D. Provide seeding and sodding as required restoring disturbed areas in accordance with Section 32 92 23, (Sodding) and/or 32 92 23.01, (Turf Establishment) within seven (7) days after main is back in service.

E. Provide temporary pavement on roadway cuts in accordance with Section 32 01 30.10, (Patch Existing Pavement and Reset Utility Services).

F. Deliver hydrants and valves removed from the lined section of water main and not reused in the Work to the Baltimore City's Maintenance yard at Washington Boulevard.

3.11 TESTING

A. The City may test the completed sections to determine the Hazen-Williams "C" Factor. If in any section of cleaned and lined water main fails to meet the guaranteed Hazen-Williams "C" Factor, the cement/mortar lining shall be removed and reinstalled properly at no additional expense to the City.

1. Removal of test section

a. When directed by the Engineer, the Contractor shall excavate, cut and remove a test section of pipe not less than two feet (2′) or more than three feet (3′) long for applied cement lining thickness verification and inspection. If the thickness is not within the requirements specified herein, the Contractor shall correct the lining thickness as directed by the Engineer. After inspection, Contractor shall reinstall the removed pipe section utilizing sleeves, backfill excavation and provide temporary paving repair as required.

b. For the purpose of establishing "C" coefficient on such mains where it is not practicable to carry the loss-of-head test through the full extent of the cleaned and cement/mortar lined main, the several sections thereof shall be tested and the weighted average coefficient "C" from tests of such portions shall be considered to be acceptable for the whole of the cleaned and cement/mortar lined main.

c. All tests for establishing the coefficient "C" for water mains cleaned and cement/mortar lined under this Contract will be completed prior to final acceptance of this job.

3.12 PIPE OPENINGS

A. All cutting of pipes shall be done by power operated pipe cutting machines capable of making fast, true, and smooth cuts so that the valves and pipe sections so removed may be readily replaced in true alignment.

B. Where difficulties due to obstructions make it impossible to use preceding method of cutting pipe, it may be cut using a method as approved by the Engineer, but no extra payment will be allowed under any circumstances. On completion of the cement/mortar lining operations, the Contractor shall close all openings by replacing the removed sections.

C. When making pipe cuts adjacent to existing valves, which are in service, the Contractor shall block or support the valve in the vault.

D. That portion of main between any pipe openings and an existing in-service valve shall be hand cleaned and lined.

3.13 COUPLINGS

A. The Contractor is to measure the outside diameter of the existing pipe and duplicate the proper dimensions when installing spool pieces. All openings cut for the installation of spool pieces shall be of minimal tolerances so as not to encourage future leaks and maintenance problems.

B. All couplings must be in compliance with AWWA C219, Bolted, and Sleeve Type Couplings for Plain End Pipe. These standards will cover bolted, sleeve type couplings, sizes four inches (4″) through twenty-four inches (24″), "stab-fit" type couplings, without the need to dismantle the coupling. In any and all cases of conflict between these Specifications and AWWA C219, these Specifications shall govern but only to the extent of such conflict.

1. Pressure Rating

   a. All couplings must be rated at least for two hundred thirty (230) psi sixteen (16 bar) working pressure and test pressure at one and one-half (1.5) times the rated working pressure, or three hundred fifty (350) psi twenty-four (24) bar.

2. Construction

   a. They may be made from carbon steel, stainless steel, or ductile iron and are intended for use in potable water systems only.
   b. All nuts and bolts shall be steel, zinc plated with an epoxy or nylon coating, or ANSI 304 Grade Stainless Steel. Bolts and nuts must be a minimum one-half inch (1/2″) diameter in size.
   c. Gaskets must be of a hydraulically assisted type, compounded with an EPDM material, suitable for potable water. Gaskets shall be molded as an integral component, of the coupling, and shall be circumferential ribbed to prevent "roll over", and ensure a watertight seal on scoured, pitted or corroded pipe surfaces, during the installation.

3. Coatings

   a. These couplings must be coated both internally and externally with NSF-61 Approved Fusion Bonded Epoxy Coatings, or Rilsan Nylon, conforming to AWWA C213. Acceptable Couplings – sizes four inch (4″) through twenty-four inch (24″).

3.14. IN LINE VALVES AND FIRE HYDRANT VALVES

A. All existing valves through which the cleaner, and/or lining machine will traverse are to be replaced by the Contractor with new Baltimore Standard resilient wedge gate valves. Also, all existing fire hydrant valves, unless indicated otherwise, shall be removed and replaced. All valves, on fire hydrant leads, must be restrained back to the tee, of the feed main.

B. The Contractor will be responsible for excavation, backfill, couplings, vault installations, and all labor and equipment to do the Work.

C. The Contractor will furnish all new valves unless otherwise specified in these Contract Documents. Vault sections, frames, and covers disturbed by this Work and which in the opinion of the Engineer are in a deteriorated condition, will be supplied to the Contractor at no cost. However, should the Contractor through its operations damage any vault sections, roadway boxes/sectional vaults, frames and covers it will be required to replace them at no cost to the City.

D. The Contractor must return all the existing valves, vault sections, roadway boxes, frames and covers not reused to the Baltimore City's Maintenance yard at Washington Boulevard.

E. The Contractor is instructed not to clean through any large diameter valves thirty to thirty-six inches (30″ to 36″). When pressure is on one side of the large diameter valve the valve must be blocked in the valve vault. Then, hand clean and line as close to valve as possible without damaging seats of valve. When there is no pressure on valve, the Contractor should clean and line as close as possible to the valve without damage.

3.15. FITTING/VALVE ABANDONMENT

A. All cutting of pipe shall be done by a power operated pipe cutting machine capable of making fast, true, and smooth cuts so that the removed fittings may be replaced by pipe sections in true alignment.

B. Where difficulties due to obstructions make it impossible to use the preceding method of cutting pipe, it may be cut using a method as approved by the Engineer, but no extra payment will be allowed under any circumstances.

C. Where indicated on the Contract Drawings, the Contractor shall remove the existing fitting/valve and install a small section of ductile iron pipe of equal size. Where possible the Contractor is to utilize these pits for its cleaning and lining Work.

D. Upon completion of the cement/mortar lining operations, the Contractor shall close the opening using a small section of ductile iron pipe of equal size and (approved) Couplings.

3.16. GUARD RAIL W-BEAMS

A. Guard rail W-Beams required to be removed in order to excavate, gain equipment access, etc. should be included in the unit cost of these items.

B. The Contractor will be required to remove and replace any and all guard rail W-Beams every evening or when no Work is being performed at the site.

3.17. EXISTING FIRE HYDRANTS

A. In-Line (on water mains to be cleaned and lined/or on bypass piping only)

B. All existing fire hydrants—In-Line, unless otherwise noted, shall be removed and replaced on water mains that are to be cleaned and lined/or on bypass piping.

C. Fire hydrants that are replaced should be delivered to the Baltimore City's Maintenance yard at Washington Boulevard.

D. All fire hydrant lead piping, ten feet (10′) and under, shall be replaced with new ductile iron pipe and all fire hydrant lead piping over ten feet (10′) shall be cleaned and lined. All fire hydrant tees shall be replaced and the fire hydrant valve restrained back to the feed main.

E. Modified Large Service Connection

F. This item of Work is to be installed to allow a below ground connection from the temporary bypass piping to the existing service. The purpose is to maintain normal water service to consumers. This will avoid disconnecting meters by cutting and installing a bypass connection on the service lead.

G. All ductile iron pipe and fittings shall comply with Sections 33 11 13, (Public Water Utility Distribution Piping) and 33 00 02, (Corrosion Control) and 33 12 16 (Water Valves and Appurtenances) of the Standard Specifications.

H. The modified large service connections consist of locating and excavating the existing service line, cutting out a section of pipe and installing a new gate valve and temporary tee with sleeve and spacer or ductile iron pipe and coupling. Refer to the detail in the Contract Drawings. After the connection is made the Contractor shall securely plate the pit. Upon completion of cleaning and lining operations, the Contractor is to remove the temporary tee and existing valve and install a sleeve and spacer or ductile iron spool piece and coupling and roadway box and backfill.

I. Inspect the rubber gaskets on couplings when making permanent repairs. Replace them if they show signs of leakage or if directed by the Engineer.

J. All stainless steel nuts and bolts must be field coated with mastic that is totally resistant to aliphatic hydrocarbons, such as Royston Roskote Mastic A 51 plus or an approved equal.

3.18. BELOW GROUND MAIN FEEDS

A. The below ground feed shall consist of locating and excavating an existing main, and cutting out a section of pipe, in order to install temporary bypass piping to the main, so as not to install bypass piping to the services.

B. The existing pipe shall be fitted with a tapping sleeve and valve or tee/fitting and a temporary valve, which must be totally removed after the bypass piping is no longer needed. The existing main shall be repaired with a new ductile iron sleeve and spacer or a ductile iron spool piece and couplings.

PART 4 MEASUREMENT AND PAYMENT

A. The cleaning and lining shall be measured for payment by the linear foot of main actually cleaned and lined, measured horizontally along the centerline of pipe with no deductions made for fittings or valves.

B. Payment will be made at the unit price per linear foot for each size of pipe cleaned and lined as listed in the Schedule of Prices which meets the guaranteed Hazen-Williams "C" Factor test requirements.

C. Payment shall include in full for installing in line valves, removing and installing all fire hydrant valves and removing and installing all fire hydrants, in-line, on mains to be cleaned and lined, checking for "open" position of all valves installed, all existing tees on mains below sixteen inch (16″), restrained joints, ductile iron pipe and fittings for fire hydrant leads, furnishing, installing and maintaining temporary bypass piping, below ground feeds, modified service connections, service valves, ductile iron pipe for service reconnections done as a modified service connection, furnishing and installing sheeting and shoring, all labor, tools, materials (including D.I.P. and fittings), notifications, equipment, excavation, backfilling, temporary and permanent paving restorations, pumping, testing and any incidentals (which includes in line and service fitting and valve removals) necessary to complete the cleaning and lining Work.

33 31 00 SANITARY SEWERAGE UTILITIES

33 31 00 SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.2 DESCRIPTION

Sanitary sewer and sanitary house connection installation shall include, but not necessarily be limited to furnishing and installing gravity pipe, fittings, and appurtenances of the size and type shown on the Plans, installed on firm foundation true to line and grade and in accordance with the Contract Documents.

2.2 QUALITY ASSURANCE

A. Test materials as set forth in the applicable referenced Specifications and as required herein.

B. The Engineer may inspect and test all pipe, fittings and joint material upon delivery to the site or at the factory. The pipe manufacturer or supplier shall furnish materials to be tested and labor as required to assist the Engineer with the inspections and tests. The Engineer may perform on a continual basis plant certification and in-process inspections.

C. Requirements for inspection and testing of Reinforced Concrete Pipe:

1. Reinforced concrete pipe conforming to the Specifications will be accepted on the manufacturer's certification based on the requirements outlined below. This includes the sampling, testing, documentation, and certification of the product by the manufacturer.
2. Shipment: Units may be shipped to the City's projects under either of the following conditions:

    a. The required testing for all units in the lot has been completed with acceptable results and all of the units to be shipped are at least the age of the test specimens at testing.
    b. Units otherwise conforming to all test criteria may be shipped prior to completion of absorption testing if the concrete mix and manufacturing process used have historically produced the required absorption results, with final acceptance pending acceptable test results.
    c. The quality control stamp shall be affixed to each unit shipped.

3. Certification: A manufacturer's certification shall accompany each shipment of pipe. A copy of the certification shall be delivered to the Engineer and the Contractor for each shipment. The certification shall include the following:

    a. The plant name, address, and location.
    b. Size and class of the pipe.
    c. Date of manufacture and shipment.
    d. Number of units or linear feet.
    e. City Contract number.
    f. Statement of Specification compliance.
    g. Signature of the quality control manager.

4. Provide hydrostatic tests for reinforced concrete pipe for sewers in accordance with ASTM C497 as follows:

   a. For the hydrostatic test, pipes for gravity sewers shall withstand a minimum internal hydrostatic pressure of thirteen (13) psi for ten (10) minutes with no leakage. Pipes will be allowed to soak under reduced pressure for a maximum of twenty-four (24) hours before testing. Moisture appearing in the form of patches or beads, which do not, result in runs on pipe walls will not be considered leakage, provided the pipe walls are dry upon retesting at the prescribed test pressure after elapse of not more than twenty-four (24) hours. Test pressure may be maintained between initial test and retest at the option of the manufacturer. At the manufacturer's option, a standpipe calibrated in one-half foot (1/2′) increments with permanent markings may be used in lieu of a calibrated pressure gauge. The standpipe shall be high enough to develop the specified water pressure and shall be equipped with an overflow line adjusted to a height for developing the specified pressure. A continuous stream of water shall flow from the overflow line during the test and be visible from the test site.

   b. If the pipe fails to withstand the pressure test, the manufacturer shall test two (2) other lengths of pipe for each length of pipe that failed, selected at random by the Engineer from the same day's production from which the failed pipe was selected. If these pipes pass the test, the remainder of that day's production represented by the test specimens may be accepted. If either of the newly tested lengths of pipe fails the test, each length of pipe in that day's production shall pass the test before that day's production represented by the test specimen is accepted.

   c. Each length of reinforced concrete pipe that is not centrifugally cast in accordance with AWWA C302 shall be subjected to and pass the hydrostatic test before delivery to the Contract site.

   d. Pipe will be considered ready to inspect for acceptance for installation after it meets requirements of the specified tests. Before inspection of pipe for a Contractor's order is scheduled, the pipe manufacturer or supplier shall provide the Engineer with the City Contract Number, Contractor's name, pipe diameters, design and classes, and footage of pipe included in the order. An adequate quantity of pipe of the required diameters, design and classes shall be available for the inspection.

2.2 SUBMITTALS

A. Submit certificates of compliance before delivery of materials in accordance with 01 33 00, (Submittal Procedures) for pipe and fittings furnished by the Contractor under this Section. Certificates shall include City Contract Number, job location, Contractor's name, types, classes and strengths of pipe and pipe manufacturer's name. Certificates of compliance for concrete materials are specified in 03 30 00, (Portland Cement Concrete Structures).

B. Submit certified test reports of source quality control tests performed on PVC pipe at point of manufacture.

C. A packing list or invoice shall accompany every shipment and shall contain the following information; City Contract Number, kind and class of pipe, length and other pertinent information.

D. Installation and Repair Recommendations.

1. Submit manufacturer's recommended installation procedures for pipe, and structures.
2. Submit recommended repair methods and procedures for defects and damage to reinforced concrete pipe from manufacturer furnishing product. Repairs shall be performed by the manufacturer using specifically trained personnel and shall proceed only after approval of the Engineer and in its presence.

PART 2 PRODUCTS

2.1 MATERIALS

A. Polyvinyl Chloride (PVC) Pipe and Fittings.

1. PVC Pipe:

a. Use and application of this pipe and fittings, as it relates to Sanitary Sewer, shall only be for gravity sanitary sewer. Pipe and fittings six inch (6″) through fifteen inch (15″) diameter shall meet the material requirements of ASTM D-3034, wall thickness classification SDR 35 or ASTM F-789, wall thickness T-1. Pipe and fittings eighteen inch (18″) through twenty-seven inch (27″) diameter shall meet the material requirements of ASTM F-679, wall thickness T-1 and ASTM F1803. Fittings shall meet or exceed ASTM D-1784, ASTM D-3034, ASTM D-3212-76, and ASTM F-477 Specifications.
b. Use of SDR-35 PVC pipe and fittings will not be allowed when the depth of cover exceeds fifteen feet (15′).
c. Joints shall be elastometric gasketed, per ASTM F-477.

B. Reinforced Concrete Pipe (RCP) and Fittings.

1. Use and application of this pipe and fittings, as it relates to sanitary sewer, shall only be for gravity sanitary sewer. Circular reinforced concrete pipe and fittings shall meet the material requirements of M170, Class 4 & 5. Pipe shall have bell and spigot ends with rubber gasket joints meeting material requirements of ASTM C 361.
2. Concrete Y-branches or tee fittings and bends shall be fabricated and assembled in the manufacturing plant. The fabrication of Y-branches or tees and bends shall be to the angle and radius shown and the interior shall permit the smooth and even flow of liquid.
3. The reinforced concrete pipe manufactured by the method described in the Concrete Pipe Handbook, machine made Packerhead Pipe, will not be accepted.

C. Cast Iron Soil Pipe and Fittings.

1. Cast iron soil pipe and fittings for sanitary house connections outside the public right-of-way or on risers shall meet material requirements of ASTM A 74, service weight or heavier with leaded, mechanical, or gasketed joints.
2. Cast iron caps are required for all sanitary house connections and shall meet the material requirements of ASTM A 74. Use of Traffic Bearing Cleanout Cover Assembly is required in paved areas.

D. Ductile Iron Pipe (DIP) and Fittings and Cast Iron Fittings shall be as specified in 33 11 00, (Water Distribution System) except the minimum working pressure specified therein will not apply. Pipe class shall be minimum Class 52 or as shown on the Plans.

E. Vitrified Clay Pipe and fittings shall be used only as approved by the City and shall meet requirements of ASTM C700, Extra Strength.

F. Polymer Concrete Pipe.

1. The polymer concrete pipe shall be designed, manufactured and tested in accordance with ASTM D6783.
2. The polymer concrete pipe installed for gravity service shall use a stainless steel joint. The stainless steel sleeve/couplings shall use an elastomeric gasket to maintain joint watertightness. The joint shall meet the performance requirements of ASTM A276.

G. Fiberglass Pipe. The fiberglass pipe shall be designed, manufactured and tested in accordance with ASTM D3262. The pipe joints using flexible elastomeric seals shall meet the requirements of ASTM D4161.

H. PCCP Pipe. Prestressed concrete pressure pipe and fittings, steel cylinder type, shall conform to the latest edition of AWWA C301 and C304.

I. Connection Appurtenances.

The Contractor shall place "Y" branches along the line of pipe drains or sewers at such places as may be designated by the Engineer. All branches from which connections are not extended by the Contractor shall be closed with approved stoppers suitable for an "O" ring rubber gasket joint.

PART 3 EXECUTION

3.1 PREPARATION

A. Trench excavation, backfill, and compaction, 31 23 33, (Trenching and Backfilling).

B. The pipeline trench excavation shall be dewatered sufficiently to allow pipe joints to be made under dry conditions. No joint shall be made under water.

C. No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when there is danger of ice formation or frost penetration at the bottom of the excavation. In freezing weather, open trench length shall be kept to a minimum and the excavation promptly backfilled after the pipe has been installed.

D. Each pipe shall be bedded on a solid foundation acceptable to the Engineer. Bell holes shall be dug sufficiently large to insure that joints are properly made and the pipe is firmly bedded for the full length of the barrel. Gravel bedding material shall be placed to full trench width and specified depth for proper pipe installation in accordance with 31 23 33, (Trenching and Backfilling), and the standard details.

3.2 MAINTAINING SEWER SERVICE

A. Existing sewer service shall be maintained at all times. The Contractor shall conduct its operations so as to maintain flows in existing sewers draining through the project area. This will require the proper coordination between construction replacement and abandonment so as not to block the flow in existing sewers that are to remain in service.

B. When necessary to pump sewage while replacing and installing relief sewers, the material pumped shall be carried by means of approved hose or other closed, watertight conveyors to the downstream sewer or manhole designated by the Engineer. Sewage shall not be allowed to flow into or over the street surfaces.

3.3 PIPE INSTALLATION

A. All pipe shall be installed in accordance with the recommendations of the pipe manufacturer and as specified herein. These recommendations shall include maximum trench width, if more restrictive than that shown in the Standard Details; bedding requirements; backfill material and compaction, where applicable. In addition, the following shall apply unless otherwise noted:

1. Reinforced concrete pipe (RCP) shall be installed as follows:

   a. Pipe lengths and gradients shall be verified by the Contractor and shall be acceptable to the Engineer before installation.
   b. Pipe End walls, when visible from the roadway, shall be constructed parallel to the roadway and askew pipe shall protrude through the end wall. End walls, not visible from the roadway, shall be constructed normal to the center line of the pipe.
   c. The existing pipes shall be cleaned and the material disposed of as directed by the Engineer.

2. Ductile iron pipe (DIP) and cast iron soil pipe shall be installed in accordance with 33 11 00, (Water Distribution System):

   a. Align pipe so that no shoulder or unevenness results on the inside of the main.
   b. Cutting, where required, shall be smooth and at right angles to the pipe axis.
   c. Cutting shall be performed at no cost to City.
   d. Secure pipes, fittings and valves in place in the manner indicated on the Contract Plans.

3. Where indicated, provide erosion checks and concrete anchors in accordance with the Standard Details. If no method for securing pipe is indicated, secure with wooden wedges or braces and concrete to the satisfaction of the Engineer.
4. Unless otherwise indicated, joint opening for push on and mechanical joints, horizontal or vertical deflections shall not exceed four degrees (4°) for pipe twelve inch (12″) and smaller diameter, three (3) degrees for pipe fourteen and sixteen inches (14″ and 16″) in diameter, two (2) degrees for pipe eighteen to thirty inches (18″ to 30″) in diameter, one and a one-half (1-1/2) degree for thirty-six to forty-eight inch (36″ to 48″) in diameter and one (1) degree for pipe larger than forty-eight inches (48″) in diameter.

5. Deflections horizontal or vertical greater than these shall be made with fittings approved by the Engineer.

a. Polyvinyl chloride (PVC) pipe shall be installed in accordance with the Standard Details and the following:

b. PVC pipe shall be handled with care to avoid severe impact blows, abrasion damage, gouging and cutting by metal surfaces or rocks, and never handled with individual chain or single cable, even if padded. Exposure to sources of heat or hot objects such as heaters, boilers, steam lines, and engine exhaust shall be avoided. Gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. Handling techniques in cold weather require more care than during hot weather. Each pipe unit will be inspected for straightness and damage before being installed in the Work. Defective pipe and fittings shall be removed and replaced with approved materials at no additional cost to the City.

c. Assembly of the gasket joint shall be performed as recommended by pipe manufacturer. All joint surfaces shall be cleaned immediately before joining; the bell and beveled spigot shall be lubricated with an approved lubricant, and then carefully pushed into place. A suitable device shall be used to force the pipe units together. Good alignment of the pipe is essential for ease of assembly. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly; do not swing spigot into bell. Generally, the spigot end of the pipe is marked by the manufacturer to indicate the proper depth of insertion. If undue resistance to insertion of the end is encountered or the reference mark does not position properly, disassemble the joint and check the position of the gasket. If it is twisted or pushed out of its seat, inspect components, repair or replace damaged items, clean components, and repeat the assembly steps. If gasket was not out of position, verify proper location of the reference mark. Relocate the reference mark if it is out of position.

d. To join field cut pipe, the pipe end shall be prepared first; a square cut is required for proper assembly. The pipe can be cut with a hacksaw, handsaw, or a power handsaw with a steel blade or abrasive disc. The pipe shall be marked around its entire circumference prior to cutting to insure a square cut. Use a factory finished beveled end as a guide for proper bevel angle, depth of bevel, plus the distance to the insertion reference mark. The end shall be beveled using a pipe beveling tool or a wood rasp to the correct taper. A portable sander or abrasive disc also may be used to bevel the pipe end. Round off any sharp edges on the leading edge of the bevel with a pocketknife or a file, and then assemble as stated above.

e. Only PVC adapters shall be used to connect to the various other types of pipe. In addition, only PVC caps or plugs shall be used to bulkhead the ends.

f. Pipe bedding material shall be carefully placed in accordance with the Standard Detail and 31 23 33, (Trenching and Backfilling).

g. Material shall not be dropped directly on the pipe. After first course is placed to pipe grade, attention shall be given to carefully placing pipe and excavating for socket joints. Bedding gravel shall then be placed around pipe haunch in second course to provide correct alignment. Then, third course and finally fourth course shall be placed and consolidated to avoid pipe deflection.

h. Compaction equipment shall not be used directly over pipe until sufficient backfill has been placed to insure that such equipment will not damage or disturb pipes, usually a minimum of thirty inch (30″) depth.

B. Proper and suitable tools and appliances for safe and convenient handling and joining of pipes shall be used.

C. Pipe shall be carefully handled and lowered into the trench. Pipe shall be installed with special care to insure that each length abuts against the next to produce no shoulder or unevenness of any kind along the inside bottom half of the pipeline. No wedging or blocking will be permitted in installing any pipe unless directed by written order or permission in writing is obtained from the Engineer.

D. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Care shall be used to assure watertightness and prevent damage to, or disturbing of, the joints during the refilling process. After pipes have been installed and joints have been made, there shall be no walking on or working over the pipe, except as may be necessary in tamping the backfill material, until the backfill is at least two feet (2′) over the top of the pipe.

E. The pipes shall be thoroughly cleaned before being installed and shall be kept clean until acceptance of the completed Work. Open ends of all pipelines shall be provided with a stopper carefully fitted to keep dirt and other substances from entering. This stopper shall be kept in the end of the pipeline at all times when installation is not in progress.

3.4 SANITARY HOUSE CONNECTIONS

A. No taps of existing public sewers shall be made by the Contractor except under the supervision of the Water and Waste Water Maintenance Division or the Engineer.

B. Joints must be made under dry conditions. If water is present, necessary steps shall be taken to dewater the trench.

C. Damaged pipe and joints will be rejected and shall be removed from the job site by the Contractor.

D. Sewer house connections shall be constructed to terminate at a right angle to the property line unless otherwise noted on the Plans. Ends at each lot shall terminate in a standard cleanout as shown on the Standard Detail and shall be capped, braced, and marked a piece of two inch by four inch (2″ X 4″) lumber, painted green, placed vertically from the bottom of the trench and extending two feet (2′) above grade. Caps shall be watertight and braced so as not to be dislodged.

E. Where possible, place connections simultaneously with construction of new main line sewer before backfilling main line sewer. The Contractor shall place “Y” branches along the line of pipe drains or sewers at such places as may be designed by the Engineer. All branches from which connections are not extended by the Contractor shall be closed with approved stoppers suitable for an “O” ring rubber gasket joint.

F. Install connection pipe at a minimum two percent (2%) grade, unless otherwise indicated on Drawings.

G. Close the upper end of each house connection with a waterproof stopper. Terminate cast iron pipe at property line with bell end and plug. Terminate PVC pipe at property line with plain end and cap.

H. Concrete for the support of Y-branches and bends shall be placed as shown in the Standard Details, or as directed by the Engineer.

3.5 SEWER HOUSE CONNECTION TO EXISTING MAIN LINE SEWER

When a new house connection is to be connected to an existing main line sewer, it should be done as shown on the Standard Details and as directed by the engineer.

3.6 ABANDONMENT

When specified in the Contract Documents or when directed by the Engineer, abandoned pipes shall be plugged using Concrete Mix No. 2 or brick masonry.

3.7 FIELD TESTS

A. General

1. The Contractor shall furnish all labor, tools, materials, and equipment (as approved by the City) necessary to perform the specified tests. Testing shall be conducted only after the section of sewer in question has passed the visual inspection.
2. Generally sewers will be tested from manhole to manhole or from manhole to terminus of the pipeline if there is no manhole at the other extremity. Testing shall be by low pressure air and/or infiltration/exfiltration as specified herein and/or as determined by the Engineer.
3. If the sanitary sewer or sanitary house connection fails any test specified herein, the Contractor shall, at the Contractor's own expense, repair or replace any defective component and retest the failed section or component until all requirements are met. Repairs to defective material are to be made in accordance with the manufacturer's recommendation as approved by the City.
4. The Contractor shall schedule the proposed tests with the Engineer at least forty-eight (48) hours in advance. Tests shall be performed in the presence of the Engineer.

B. Low Pressure Air Test

1. Test gravity sewers including house connections with low air pressure after completion of backfill. Field testing shall commence when not more than one thousand feet (1000') sewer has been completed and shall include immediate remedial required repair, replacement or modification to the installation procedures if the test section fails the test. At no time shall the pipe installation precede the field testing by more than one thousand feet (1000') unless approved by the Engineer. Before placing testing apparatus, inspect sewers and manholes and eliminate discernible water leaks. The Contractor may perform preliminary tests at its own discretion for its information, without the presence of the Engineer, at no cost to the City. The Contractor has the option before air testing reinforced concrete pipe to soak the interior with clean water. Remove water before air testing begins.

2. Conduct test as follows: provide test plugs at each manhole and/or terminus and securely brace. Provide suitable means of determining depth of ground water level above the inverts immediately before testing. The Engineer will increase gauge pressures accordingly but the total pressure including the increased amount of ground water backpressure at the springline of the pipe shall not exceed five and one-half (5.5) psi. Add air slowly to the test section until the internal air pressure, as indicated on the gauge, stabilizes at four (4) psi or at the increased pressure determined for the correction of the groundwater backpressure. Do not allow personnel in manholes while test is being performed or when test section is under air pressure. If leakage is indicated at the test plugs, relieve pressure before taking steps to eliminate the leak. When the air pressure is stabilized, disconnect hose and compressor and allow pressure to decrease to three and one-half (3.5) psi, plus correction for groundwater backpressure. Record the time period for the following:

   a. For pipe twenty-seven inch (27") and smaller diameter, pressure drop one-half (1/2) psi, from three and one-half to three (3.5 to 3.0) psi plus groundwater correction. Pipes failing to maintain minimum holding times set forth in the Air Test Tables included herein will not be accepted. If the gauge needle does not drop at all after minutes holding time for test sections where the minimum holding time set forth in the tables exceeds five (5) minutes, the test section is considered to have passed the air test.
   b. If test section fails the test, the Contractor shall make repairs or replacement as required at no cost to the City and retest as specified herein. The City will perform its part of the test for particular test segment three (3) times without charge to the Contractor. Cost of further tests will be will be deducted from monies owed the Contractor.

AIR TEST TABLES – ALL PIPES OTHER THAN RCP

Minimum Holding Time in Minutes: Seconds Required for Pressure Drop From Three and One-Half to Three (3.5* to 3.0*) PSIG

LENGTH OF TEST STATION	PIPE DIAMETER											
	4″	**6″**	**8″**	**10″**	**12″**	**15″**	**16″**	**18″**	**20″**	**21″**	**24″**	**27″**
25	2:00	3:00	4:00	4:30	5:30	7:00	7:30	8:30	9:30	10:00	11:30	14:30
	|	|	|	|	|	|	|	|	|	|	|	|
50	|	|	|	|	|	|	|	|	|	|	|	|
	|	|	|	|	|	|	|	|	|	|	|	|
75	|	|	|	|	|	|	|	|	|	|	|	|
	|	|	|	|	|	|	|	|	|	|	|	|
100	|	|	|	|	|	|	|	|	9:30	10:00	11:30	14:30
	|	|	|	|	|	|	|	|				
125	|	|	|	|	|	|	|	8:30	10:00	11:00	14:30	18:00
	|	|	|	|	|	|	|					
150	|	|	|	|	|	7:00	7:30	9:30	12:00	13:00	18:00	21:30
	|	|	|	|	|							
175	|	|	|	|	|	8:00	9:00	11:00	14:00	15:30	20:00	25:00
	|	|	|	|	|							
200	|	|	|	|	5:30	9:00	10:00	13:00	16:00	17:30	23:00	29:00
	|	|	|	|								
225	|	|	|	4:30	6:30	10:00	11:30	14:30	18:00	19:30	25:30	32:30
	|	|	|									
250	|	|	|	5:00	7:00	11:00	12:30	16:00	20:00	22:00	28:30	36:00
	|	|	|									
275	|	|	|	5:30	8:00	12:30	14:00	17.3	22:00	24:00	31:30	39:40
	|	|	|									
300	|	|	|	6:00	8:30	13:30	15:00	19:00	24:00	26:00	34:00	43:30
	|	|	|									
325	|	|	|	6:30	9:30	14:30	16:30	21:00	25:30	28:30	37:00	47:00
	|	|	|									
350	|	|	4:30	7:00	10:00	15:30	17:30	22:30	27:30	30:30	40:00	50:30
	|	|										
375	|	|	5:00	7:30	10:30	16:30	19:00	24	29:30	32:30	42:30	54:00
	|	|										
400	2:00	3:00	5:00	8:00	11:30	18:00	20:30	25:30	31:30	35:00	45:30	57:30

* Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed five and one-half (5.5) PSIG.

CP PIPE – AIR TEST TABLE

Minimum Holding Time in Minutes: Seconds Required for Pressure Drop From Three and One-Half to Three (3.5* to 3.0*) PSIG

LENGTH OF TEST STATION	PIPE DIAMETER						
	18"	21"	24"	27"	30"	33"	36"
25	1:00	1:00	1:00	1:00	1:00	1:30	1:30
50	1:00	1:30	2:00	2:00	2:30	2:30	3:00
75	2:00	2:00	2:30	3:00	3:30	4:00	4:30
100	2:30	3:00	3:30	4:00	5:00	5:30	6:00
125	3:00	3:30	4:30	5:30	6:00	7:00	7:30
150	3:30	4:30	5:30	6:30	7:00	8:00	9:00
175	4:00	5:00	6:00	7:30	8:30	9:30	10:30
200	5:00	6:00	7:00	8:30	9:30	11:00	12:00
225	5:30	6:30	8:00	9:30	11:00	12:00	13:30
250	6:00	7:30	9:00	10:30	12:00	13:30	15:00
275	6:30	8:00	9:30	11:30	13:00	15:00	16:30
300	7:00	9:00	10:30	12:30	14:30	16:00	18:00
325	8:00	9:30	11:30	13:30	15:30	17:30	19:30
350	8:30	10:30	12:30	14:30	17:00	19:00	21:00
375	8:30	11:00	13:30	16:00	18:00	20:30	22:30
400	9:30	12:00	14:00	17:00	19:00	21:30	24:00
425	10:00	12:30	15:00	18:00	20:30	23:00	25:30
450	11:00	13:30	16:00	19:00	21:30	24:30	27:00
475	11:30	14:00	17:00	20:00	23:00	25:30	28:30
500	12:00	15:00	18:00	21:00	24:00	27:00	30:00
525	12:30	15:30	18:30	22:00	25:00	28:30	31:30
550	13:00	16:30	19:30	23:00	26:30	29:30	33:00

* Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed five and one-half (5.5) PSIG.

NOTE: For test sections with a minimum holding time exceeding five (5) minutes: If guage needle has dropped zero (0.0) PSIG from starting pressure after five (5) minutes, section will be considered to have passed air test.

AIR TEST TABLES FOR MAIN LINE WITH HOUSE CONNECTION

Minimum Holding Time in Minutes: Seconds Required for Pressure Drop from Three and One-half to Three (3.5* to 3.0*) PSIG. *Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed five and one-half (5.5) PSIG.

Length of 4 Inch Diameter House Connection Test Section, in Feet	Length of 6 inch Diameter Main Line in Test Section, in Feet															
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
50	4:30	5:00	5:00	5:00	5:30	5:30	5:30	5:30	5:30	5:30	5:30	5:30	5:30	5:30	5:30	6:00
100	4:30	4:30	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:30	5:30	5:30	5:30	5:30	6:00	6:30
150	4:00	4:30	4:30	4:30	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:30	6:00	6:30	6:30
200	4:00	4:30	4:30	4:30	4:30	5:00	5:00	5:00	5:00	5:00	5:00	5:30	6:00	6:00	6:30	7:00
250	4:00	4:00	4:30	4:30	4:30	4:30	4:30	5:00	5:00	5:00	5:30	6:00	6:00	6:30	7:00	7:30
300	4:00	4:00	4:30	4:30	4:30	4:30	4:30	4:30	5:00	5:30	6:00	6:00	6:30	7:00	7:30	7:30
350	4:00	4:00	4:30	4:30	4:30	4:30	4:30	5:00	5:30	6:00	6:00	6:30	7:00	7:00	7:30	8:00
400	4:00	4:00	4:00	4:30	4:30	4:30	5:00	5:30	5:30	6:00	6:30	7:00	7:00	7:30	8:00	8:30

Note: For test sections with a minimum holding time exceeding five (5) minutes: If gage needle has dropped zero (0.0) psig from starting pressure after five (5) minutes, section will be considered to have passed air test.

Length of 4 Inch Diameter House Connection Test Section, in Feet	Length of 8 inch Diameter Main Line in Test Section, in Feet															
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
50	5:30	6:30	6:30	7:00	7:00	7:00	7:00	7:00	7:00	7:00	7:30	8:00	8:30	9:00	10:00	10:30
100	5:00	5:30	6:00	6:30	6:30	6:30	6:30	7:00	7:00	7:00	7:30	8:00	9:00	9:30	10:00	11:00
150	4:30	5:30	5:30	6:00	6:00	6:30	6:30	6:30	6:30	7:30	8:00	8:30	9:00	10:00	10:30	11:00
200	4:30	5:00	5:30	5:30	6:00	6:00	6:00	6:30	7:00	7:30	8:00	9:00	9:30	10:00	11:00	11:30
250	4:30	5:00	5:00	5:30	5:30	6:00	6:00	6:30	7:30	8:00	8:30	9:00	10:00	10:30	11:00	11:30
300	4:30	4:30	5:00	5:30	5:30	5:30	6:30	7:00	7:30	8:00	9:00	9:30	10:00	11:00	11:30	12:00
350	4:00	4:30	5:00	5:00	5:30	6:00	6:30	7:30	8:00	8:30	9:00	10:00	10:30	11:00	11:30	12:30
400	4:00	4:30	5:00	5:00	5:30	6:30	7:00	7:30	8:00	9:00	9:30	10:00	11:00	11:30	12:00	12:30

AIR TEST TABLES FOR MAIN LINE WITH HOUSE CONNECTION

Minimum Holding Time in Minutes: Seconds Required for Pressure Drop from Three and One-Half to Three (3.5* to 3.0*) PSIG. *Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed five and one-half (5.5) PSIG.

		Length of 8 Inch Diameter Main Line in Test Section, in Feet															
		25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
Length of 6 Inch Diameter House Connection in Test	50	6:30	6:30	7:00	7:00	7:00	7:00	7:00	7:30	7:30	7:30	7:30	8:30	9:00	9:30	10:00	11:00
	100	6:00	6:30	6:30	6:30	7:00	7:00	7:00	7:00	7:00	8:00	8:30	9:00	9:30	10:30	11:00	11:30
	150	6:00	6:00	6:30	6:30	6:30	6:30	7:00	7:00	8:00	8:30	9:00	9:30	10:30	11:00	11:30	12:30
	200	6:00	6:00	6:30	6:30	6:30	6:30	7:30	8:00	8:30	9:00	10:00	10:30	11:00	11:30	12:30	13:00
	250	6:00	6:00	6:00	6:30	6:30	7:30	8:00	8:30	9:30	10:00	10:30	11:00	12:00	12:30	13:00	13:30
	300	6:00	6:00	6:00	7:00	7:30	8:00	8:30	9:30	10:00	10:30	11:00	12:00	12:30	13:00	14:00	14:30
	350	6:00	6:00	7:00	7:30	8:00	9:00	9:30	10:00	10:30	11:30	12:00	12:30	13:00	14:00	14:30	15:00
	400	6:30	7:00	7:30	8:30	9:00	9:30	10:00	11:00	11:30	12:00	12:30	13:30	14:00	14:30	15:00	16:00

Note: For test sections with a minimum holding time exceeding five (5) minutes: If gage needle has dropped zero (0.0) psig from starting pressure after five (5) minutes, section will be considered to have passed air test.

		Length of 10 Inch Diameter Main Line in Test Section, in Feet															
		25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
Length of 4 Inch Diameter House Connection in Test	50	7:00	8:00	8:00	8:30	8:30	9:00	9:00	9:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
	100	6:00	7:00	7:30	8:00	8:00	8:00	8:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30
	150	5:30	6:30	7:00	7:00	7:30	8:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
	200	5:00	6:00	6:30	7:00	7:00	7:30	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
	250	5:00	5:30	6:00	6:30	7:00	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30
	300	4:30	5:30	6:00	6:30	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	16:30	17:30
	350	4:30	5:30	5:30	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
	400	4:30	5:00	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30

AIR TEST TABLES FOR MAIN LINE WITH HOUSE CONNECTION

Minimum Holding Time in Minutes: Seconds Required for Pressure Drop from 3.5* PSIG to 3.0* PSIG. *Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed 5.5 PSIG.

Length of 6 Inch Diameter House Connection in Test	Length of 10 Inch Diameter Main Line in Test Section, in Feet															
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
50	7:30	8:00	8:30	8:30	8:30	9:00	9:00	9:00	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30
100	7:00	7:30	8:00	8:00	8:00	8:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:00
150	6:30	7:00	7:30	7:30	8:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
200	6:30	7:00	7:00	7:30	8:00	9:00	10:00	11:00	12:00	12:30	13:30	14:30	15:30	16:30	17:30	18:30
250	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30	19:30
300	6:00	6:30	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00
350	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
400	6:30	7:30	8:30	9:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	17:30	18:30	19:30	20:30	21:30

Note: For test sections with a minimum holding time exceeding 5 minutes: If gage needle has dropped 0.0 psig from starting pressure after 5 minutes, section will be considered to have passed air test.

Length of 4 Inch Diameter House Connection in Test	Length of 12 Inch Diameter Main Line in Test Section, in Feet															
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
50	8:30	9:30	10:00	10:30	10:30	10:30	10:30	11:30	13:00	14:30	16:00	17:30	19:00	20:30	21:30	23:00
100	7:00	8:30	9:00	9:30	10:00	10:00	10:30	12:00	13:30	15:00	16:30	17:30	19:00	20:30	22:00	23:30
150	6:30	7:30	8:30	9:00	9:00	9:30	11:00	12:30	14:00	15:00	16:30	18:00	19:30	21:00	22:30	23:30
200	6:00	7:00	8:00	8:30	8:30	10:00	11:00	12:30	14:00	15:30	17:00	18:30	20:00	21:00	22:30	24:00
250	5:30	6:30	7:30	8:00	8:30	10:00	11:30	13:00	14:30	16:00	17:00	18:30	20:00	21:30	23:00	24:30
300	5:30	6:30	7:00	7:30	9:00	10:30	12:00	13:30	14:30	16:00	17:30	19:00	20:30	22:00	23:00	24:30
350	5:00	6:00	6:30	8:00	9:30	11:00	12:00	13:30	15:00	16:30	18:00	19:30	20:30	22:00	23:30	25:00
400	5:00	6:00	7:00	8:00	9:30	11:00	12:30	14:00	15:30	17:00	18:00	19:30	21:00	22:30	24:00	25:30

AIR TEST TABLES FOR MAIN LINE WITH HOUSE CONNECTION

Minimum Holding Time in Minutes: Seconds Required for Pressure Drop from 3.5* PSIG to 3.0* PSIG. *Test pressures shall be increased by amount of groundwater backpressure at springline of pipe but shall not exceed 5.5 PSIG.

		Length of 12 Inch Diameter Main Line in Test Section, in Feet															
		25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
Length of 6 Inch House Connection in Test	50	8:30	9:30	10:00	10:00	10:00	10:30	10:30	12:00	13:30	15:00	16:30	18:00	19:00	20:30	22:00	23:30
	100	7:30	8:30	9:00	9:30	9:30	10:00	11:30	13:00	14:00	15:30	17:00	18:30	20:00	21:30	23:00	24:00
	150	7:00	8:00	8:30	9:00	9:30	10:30	12:00	13:30	15:00	16:30	18:00	19:00	20:30	22:00	23:30	25:00
	200	7:00	7:30	8:00	8:30	10:00	11:30	13:00	14:00	15:30	17:00	18:30	20:00	21:30	23:00	24:00	25:30
	250	6:30	7:30	8:00	9:30	10:30	12:00	13:30	15:00	16:30	18:00	19:00	20:30	22:00	23:30	25:00	26:30
	300	6:30	7:00	8:30	10:00	11:30	13:00	14:00	15:30	17:00	18:30	20:00	21:30	23:00	24:00	25:30	27:00
	350	6:30	8:00	9:30	10:30	12:00	13:30	15:00	16:30	18:00	19:00	20:30	22:00	23:30	25:00	26:30	28:00
	400	7:00	8:30	10:00	11:30	13:00	14:00	15:30	17:00	18:30	20:00	21:30	23:00	24:00	25:30	27:00	28:30

Note: For test sections with a minimum holding time exceeding five (5) minutes: If gage needle has dropped 0.0 psig from starting pressure after five (5) minutes, section will be considered to have passed air test.

C. Hydrostatic Test

1. Sewers over twenty-seven inches (27") diameter and manholes shall be tested by the hydrostatic method if approved air test procedure is not available.
2. Leakage shall not exceed a rate of one hundred (100) gallons per inch diameter per twenty-four (24) hours per mile of sewer.
3. Test Procedure:

    a. Where ground water is encountered in the trench during construction and the water level is expected to be over the top of the sewer pipe, the completed and connected pipe shall be tested for infiltration leakage by the exact measurement of the amount of water entering it after the pumping of ground water has been discontinued for at least three (3) days.
    b. Where the ground water level is expected to be below the top of the pipe and where the slope of the pipe between adjacent manholes will permit, the sewer shall be subjected to an internal pressure by plugging the pipe lower end and then filling the sewer and manholes with clean water to a height of two feet (2') above the top of the pipe. Upper end plugs may be needed as directed. Measurements will be made of the rate of leakage from the pipe by determining amount of water required to maintain the initial level of two feet (2') above the top of pipe. The Contractor shall provide water for this test by making arrangements with the Engineer.
    c. Each manhole and appurtenance to the system shall be watertight within the foregoing leakage limit. Repairs to all defects responsible for leakage shall be by the Contractor at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. Pipe:

1. Unless otherwise specified in the Special Provisions, measurement of sanitary sewers for payment will be on a linear foot basis and the quantity to be paid for will be the number of linear feet of pipe actually installed and accepted by the Engineer, which measurement shall be along the center line of pipe from end to end of each completed pipe line including length of fittings.
2. Unless otherwise specified in the Special Provisions payment for sanitary sewers will be made at the unit price Bid per linear foot in the proposal for various types and sizes of pipes; which prices shall include all material; labor; tools; equipment; hauling; excavating to planned trench subgrade; excavation for bell holes; sheeting and/or shoring; sills and wedges; pumping; stone or gravel cradle; backfilling with suitable material from the Project; rehandling of material; removal and disposal of unsuitable material; compacting; all fittings, stoppers, closure pieces, gaskets, and jointing; coatings; connections to existing lines; maintaining service; and all incidentals necessary to complete these items of Work.
3. Paving, sidewalk, and curbing restoration shall be measured and paid for in accordance with 32 01 30.10, (Patch Existing Pavement and Reset Utility Services.)
4. Measurement of distances for which payment will be made for pipe shall start at the points where the ends of the pipes enter manholes, brick "Y's" and other structures and shall terminate at the points where the pipes end in such structures.
5. The cost of collar taps shall be included in and covered by the unit prices Bid for pipe drains for which they form a part.

6. Whenever a pipe requires cutting, this Work shall be done as directed by the Engineer and the cost shall be included in the unit prices Bid for furnishing and laying the various size pipes.
7. Payment includes excavation, backfill and bedding, installation of the pipe, fittings, and connections to new and existing facilities, and various size drop connections at manholes.
8. Unless otherwise specified in the Special Provisions, pipe abandonments including excavation and backfill, providing concrete and all incidentals will not be measured but will be incidental to the other sewer items.

B. House Connections

1. Furnishing and installing house connections will be measured for payment by the linear foot of pipe actually installed and accepted by the Engineer, of the various types and sizes placed, measured horizontally along the centerline of the pipe. No deductions will be made for lengths of fittings. Payment will be made for the quantities measured at the unit price per linear foot for each size listed in the Bid Schedule.
2. Payment includes excavation, backfill and bedding, provisions of pipe, fittings, connections to new and existing facilities, installation of saddles, and wye "Y" connections.

C. Cleanouts

1. Providing cleanouts will be measured for payment by the each complete in place, including installation of the City furnished cover assembly for traffic areas.
2. Payment will be made for the quantities measured at the unit price per each listed in the Bid Schedule.
3. Payment includes excavation, backfill and bedding, provisions of pipe, fittings, appropriate size Y branch and appurtenances.

D. Pipe in Tunnels and Sleeves

1. Pipe in tunnels and sleeves will measured out for payment by the linear foot measured horizontally along the centerline of the pipe from inside face to inside face of access shaft.
2. Payment will be made for the quantities measured at the unit price per linear foot for each size listed in the Bid Schedule.
3. Payment includes installation of pipe, provisions if concrete or grout fill for annular space between tunnel liner or sleeve and pipe or of pipe bedding and anchors as the case may be, and all incidentals required to install the pipe in the tunnel liner of sleeve complete as shown on the Drawings.

E. Concrete Encasement and Cradle

1. Cradles of concrete and/or reinforced concrete shall be built under pipe when indicated on the Drawings and as shown on the Standard Details. Such cradles will be paid for by the cubic yard at the unit price Bid for the class of concrete shown on the Plans, or otherwise directed to be used, including reinforcing bars when required. The right for the Engineer to vary the size of the section shown is

reserved, and payment will be made only for the concrete and reinforcing steel of the section actually directed to be used.

2. Where sewers are to be encased in concrete, such concrete will be paid for by the cubic yard for the actual section shown on the Standard Details, at the unit prices Bid per cubic yard for the various classes of concrete used including supporting sills and wedges. The right is reserved to reduce the size of the section of the concrete and when such reduction is made, only the actual section of concrete directed to be used will be paid for.

33 31 13.01 CURED IN PLACE PIPE (CIPP) FOR SANITARY SEWERS

PART 1 GENERAL

1.1 DESCRIPTION

A. This item shall consist of providing all labor, equipment, materials and supplies for all Work necessary to restore existing sanitary sewers to a state equivalent to the structural and hydraulic capacities of a new pipe installation. The Work includes but is not limited to the following:

1. Providing design calculations relative to the installation of CIPP.
2. Bypass pumping of flow.
3. Cleaning the sanitary sewer.
4. Pre-rehabilitation inspection and video recording of the sanitary sewer.
5. Rehabilitation of the sanitary sewer system using CIPP lining including sealing liner at manhole.
6. Post-rehabilitation television inspection and video recording of the completed pipe section.
7. Proper removal and disposal of all waste, debris, excavated and demolished materials.

B. When complete, the rehabilitated section should:

1. Extend from one (1) manhole to the next manhole in a continuous length.
2. Provide a minimum flow capacity equal to or greater than that of the existing pipe.
3. Yield three-dimensional cross linking strength in tension, compression, and flexural modulus which is structurally sound.
4. Provide a service life which is supported by documented, independent test analysis.

C. The Contractor shall furnish all material, labor and special equipment required to accomplish the Work in accordance with these Specifications. The installation shall affect the complete interior relining of the existing sanitary sewer piping and shall result in a smooth, hard, strong and chemically inert interior finish, closely following the contours of the existing piping. The Contractor shall provide a completed system with mainline sewer and all active lateral connections in operational condition.

D. TV Inspection

1. Pre-installation TV Inspection: Pre-installation TV is a video inspection by the Contractor of sewer lines specified for rehabilitation to confirm cleaning,

location of service connections and constructability of line rehabilitation according to Drawings and Specifications.

2. Post-installation TV Inspection: Post-installation TV Inspection is a video inspection to determine that the rehabilitation and/or replacement of a sanitary sewer has been completed according to Drawings and Specifications.
3. TV Inspection Log: Information collected and recorded by each TV operator for any TV inspection effort that is submitted to the City.

1.2 REFERENCE SPECIFICATIONS

A. ASTM F 1216: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube.

B. ASTM D 543: Test Method for Resistance of Plastics to Chemical Reagents.

C. ASTM D 618: Standard Methods for Conditioning Plastics for Testing.

1.3 SUBMITTALS

The Contractor shall submit to the City a detailed plan and description outlining all provisions and precautions that the Contractor shall take regarding the handling of wastewater flows during sewer rehabilitation. The plan shall be submitted to the City for review and approval at least ten (10) days prior to commencing Work on each portion of the system to be rehabilitated. The plan must be specific and shall include, but not be limited to, the following details:

1. Schedule for installation and maintenance of bypass pumping system.
2. Staged area for pumps.
3. Bypass pump size, capacity, and number of each size to be on site and power requirements.
4. Calculations of static lift, friction losses and flow velocity (pump curves showing pump operating range shall be submitted).
5. Road crossing detail.
6. Protection against main breaks.
7. Sewer plugging method and bypass time duration for each sewer section.
8. Size, length, material, location and method of installation of suction and discharge piping.
9. Sections showing suction and discharge piping depth, embedment, select fill and special backfill.
10. Method of noise control for each pump or generator.
11. Stand-by power generator size and location.
12. Downstream discharge plan.
13. Method of protecting discharge manholes or structures from erosion and damage.
14. Thrust and retrain block sizes and locations.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials and equipment used in the lining and in the insertion process shall be of their best respective kinds and shall be as approved by the Engineer. Any materials not

approved by the Engineer prior to insertion into the piping shall be removed and replaced with approved materials at the Contractor's expense. All equipment, devices and tools required for the Contract shall be owned (or leased) and operated by the Contractor.

B. The liner shall generally consist of a corrosion resistant polyester, vinyl ester or epoxy thermosetting resin, or approved equal, impregnated flexible polyester felt or fiberglass fiber. The liner shall meet the requirements of ASTM F 1216 and shall be constructed to withstand inversion pressures, have sufficient strength to bridge missing pipe, stretch to fit irregular pipe sections and shall invert smoothly around bends. The liner shall fit tightly to the internal circumference of the existing pipe and a membrane integrally bonded to the internal circumference of the felt, thus forming a smooth, chemically inert internal flow surface. The membrane shall be a minimum of twenty-five hundredths (0.25) mm plus five percent (+5%) and shall not be considered to impart any structural strength of the liner.

C. The wall color of the interior pipe surface of the cured in place pipe after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.

D. The required structural CIPP wall thickness shall be designed in accordance with the guidelines in Appendix X1 of ASTM F 1216. In cases where ovality exceeds ten percent (10%), or where pipes are egg or oval shaped, alternative methods of design may be considered by the Engineer. The categories of design parameters noted in the following tables A thru D below shall be used, unless otherwise directed by the Engineer.

E. Common Design Parameters: Design inputs generally considered to be the same from site to site for a particular project are provided in the following Table A.

TABLE A

Common Design Parameters		
Safety Factor	2.0	Note 1
Soil Modulus	700 psi	Note 2
Soil Density	120 lb/ft^3	Note 3

Notes – Table A

Note 1: The safety factor may be reduced to one point five (1.5) at the discretion of the Engineer, normally in the case where there is accurate and detailed information known about the existing pipe and soil conditions.

Note 2: In the absence of the site specific information, the Engineer assumes a soil modulus of seven hundred (700) psi.

Note 3: In the absence of site specific information, the Engineer assumes a soil density of one-hundred twenty (120) lb/ft^3.

F. Site Specific Parameters: The information listed in the following Table B is specific to each manhole to manhole run of pipe. The Contractor shall use for design the information provided by the City/Engineer and information the Contractor collects during site visits for each manhole to manhole run.

TABLE B

SITE SPECIFIC DESIGN PARAMETERS	
Ovality	Notes 1, 2
Water Depth Above Invert	Notes 1, 3
Soil Depth Above Crown	Note 1
Live Load	Notes 1, 4
Design Condition (Both fully and partially deteriorated)	Notes 1, 5
CIPP Thickness	Notes 1, 6, 7

Notes – Table B

Note 1: Design thickness and complete site specific design, in accordance with ASTM F 1216 (Appendix XI), shall be submitted prior to beginning Work.

Note 2: The Contractor shall estimate the ovality by viewing the video information and other information provided by the City. If video information is not available, the Contractor shall assume an ovality of three percent (3%). In cases where the ovality exceeds ten percent (10%), the Contractor may consider employing alternative design methods (such as beam design methods) to determine the pipe thickness.

Note 3: CIPP subjected to traffic live loads shall be calculated by AASHTO Standard Specifications for Highway Bridges, HS-20-44 Highway Loading.

Note 4: The Contractor shall assume existing sewer collection system is fully deteriorated.

Note 5: Thickness specified (designed by the Contractor and approved by the Engineer) is the final, in ground thickness required. Measured sample thickness will not include polyurethane or polyethylene coatings, any layer of the tube not fully and verifiably impregnated with resin, or any portion of the tube not deemed by the Engineer to be a structural component of the composite.

Note 6: The Contractor must consider any factors necessary to ensure the final; cured in place pipe thickness is not less than specified (designed by the Contractor and approved by the Engineer) above. These factors include any stress applied to the material during transportation, handling, installation and cure; the host pipe's material type, condition, and configuration; weather (including ambient temperature conditions); and any other factors which are reasonably expected to be found in existing combined or sanitary sewer systems.

Note 7: Design thickness provided by the Contractor shall be evaluated by the Engineer prior to beginning Work.

G. Product Specific Design Parameters: Certain design inputs vary by manufacturer, processes design, or installation technique. These variables are listed in the following Table "C" with explanatory notes.

TABLE C

MINIMUM PRODUCT SPECIFIC DESIGN PARAMETERS		
Enhancement Factor, K	K = 7	Note 1
Initial Flexural Strength (ASTM D 790)	σ_s = 4500 psi	Note 2
Initial Flexural Modulus of Elasticity (ASTM D 790)	E_s = 300,000 psi	Note 2
Retention of Properties to Account for Long Term Effects	50%	Note 3
Long Term Flexural Modulus of Elasticity	E_L = 150,000 psi	Note 3

Notes – Table C

Note 1: Enhancement factor (K) is the additional buckling or load resistance of the rehabilitation product due to the restraining action of the host pipe. The tighter the fit of the product within the host pipe, the greater the value of K. Third party testing of external hydrostatic loading capacity of restrained pipe samples shall be conducted to verify the enhancement factor, K. The minimum values provided are based on the "Long Term" Structural Behavior of Pipeline Rehabilitation Systems," Trenchless Technology Center, 1994.

Note 2: Initial values are defined in ASTM D 790. The Engineer may, at any time prior to installation, direct the Contractor to prepare the installation for making restrained or flat plate samples (according to ASTM F 1216) and test them in accordance with the listed ASTM standards to verify initial values of physical properties. In such tests, the Contractor's samples must achieve a ninety-five percent (95%) pass rate.

Note 3: The initial flexural modulus is multiplied by the creep factor (or percentage retention) to obtain the long term values used for design. Long term values shall be verified by long term external pressure testing of circular lengths of the pipe material by third party labs prior to Bid. It is understood that the material's modulus of elasticity will not change over time; however, by convention the modulus is reduced for design purposes for all plastic pipe sections to account for the reduced ability of plastic pipe to carry loads due to the changes in pipe geometry resulting from the effects of creep over time.

Note 4: Flow Capacity: Maintenance of flow capacity of existing pipes is essential. Rehabilitated pipe shall have minimum or no change in capacity. An increase in flow capacity following rehabilitation is preferred, and in no case shall the flow capacity of rehabilitated pipes be reduced.

Note 5: Verify that installed thickness of the CIPP is within minus five percent (5%) and plus ten percent (10%) of the specified thickness. The Contractor shall take samples to determine the installed liner thickness. The results of the liner thickness measurements shall be submitted to the Engineer. Samples shall be taken from each liner thickness at each liner insertion. The costs for thickness testing shall be included in the Bid price for rehabilitation. Additional testing requirements are addressed in the CIPP Lining Testing section of this Specification.

Note 6: Resin Content: The resin content of the liner shall be ten to fifteen percent (10% to 15%) by volume greater than the volume of felt in the liner bag.

H. Chemical Resistance: The corrosion resistance of the resin system shall be tested by the resin manufacturer in accordance with ASTM D543. The result of exposure to the chemical solutions listed in the following Table "D" shall produce loss of not more than twenty percent (20%) of the initial physical properties when tested in accordance with

ASTM D543 for a period of not less than one (1) year at a temperature of seventy-three and four-tenths degrees (73.4°) F plus or minus three and six-tenths degrees (3.6°) F.

TABLE D

CONCENTRATIONS OF CHEMICAL SOLUTIONS FOR CHEMICAL RESISTANCE TEST	
Chemical Solution	Concentration, %
Tap Water (pH 6-9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	10
Petroleum Hydrocarbon Based Fuels (e.g. Gasoline, diesel, etc.)	100
Vegetable Oil[1]	100
Detergent[2]	0.1
Soap[2]	0.1
Domestic Sewage	100

[1]Cotton seed, corn, or mineral oil. [2]As per ASTM D543.

Notes – Table D

Note 1 Liner Sizing: The liner shall be fabricated to a size that when installed will neatly fit the internal circumference of the pipe to be lined. Allowance for longitudinal and circumferential stretching of the liner during installation shall be made by the Contractor.

Note 2 Length: The length of the liner shall be that which is deemed necessary by the Contractor to effectively carry out the insertion and seal the liner at the inlet and outlet of the manhole. Individual inversion runs may be made over one (1) or more manhole to manhole sections as determined.

Note 3 The Contractor shall provide a liner exhibiting the previously described properties. Prior approval of shop drawings related to any or all materials or methods of installation shall not relieve the Contractor of this responsibility.

Note 4 The resin used shall not contain fillers, except those required for viscosity control, fire retardance or as required to obtain the necessary pot life. Thixotropic agents, which will not interfere with visual inspection, may be added for viscosity control. Resins may contain pigments, dyes or colors, which will not interfere with visual inspection of the cured liner. However, the types and quantities of fillers and pigments added shall have prior approval of the Engineer.

2.2 MANUFACTURER INFORMATION

A. It shall be necessary for the Contractor to obtain the City's prior approval for all materials or processes and the City shall have the power at any time to order the Contractor to modify or discontinue any practice. All such orders shall be given in writing.

B. The Contractor shall deliver the uncured resin impregnated liner bag to the site. The bag may not be impregnated at the site. The liner bag shall be impregnated with resin not more than twenty-four (24) hours before the proposed time of installation and stored out of direct sunlight at a temperature of less than thirty-nine degrees (39°) F. The Contractor

shall provide all appropriate transport, handling and protection equipment including refrigeration or otherwise suitably cooled, transport equipment.

C. All fabricating and Contractor testing shall be carried out under cover and no materials shall be exposed to the weather until they are ready to be inserted. All materials should be protected from the weather and exposure to ultra-violet light as practical during the manufacture and installation process.

D. Each liner shall be accompanied by a certificate of conformity.

2.3 MATERIALS FOR BYPASS PUMPING

A. The Contractor shall provide the necessary stop/start controls for each pump.

B. The Contractor shall include one (1) stand-by pump of each size to be maintained on site. Back-up pumps shall be on line and isolated from the primary system by a valve.

C. Discharging Piping: In order to prevent the accidental spillage of flow, all discharge systems shall be temporarily constructed of ridged pipe with positive, restrained joints. Only materials may be used that withstand one-hundred fifty (150) psi pressures and greater and are suitable for contact with domestic sanitary sewage. Under no circumstances will aluminum "irrigation" type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the Engineer. The bypass pumping system shall be One Hundred percent (100%) watertight.

2.4 TELEVISION INSPECTION MATERIAL

A. Closed Circuit TV Equipment. Select and use closed circuit television equipment that will produce a color video CD or DVD.

B. Pipe Inspection Camera. Produce a video recording using a pan and tilt, radial viewing and pipe inspection camera that pans plus or minus two-hundred seventy-five degrees (± 275°) and rotates three-hundred and sixty degrees (360°). The television camera used for the inspection shall be satisfactorily designed and constructed for such inspection. The camera shall be operative in one hundred percent (100%) humidity conditions. Use a camera with an accurate footage counter which displays on the monitor the exact distance to the camera from the center line of the starting manhole. Use a camera with camera height adjustment so the camera lens is always centered at one-half (1/2) the inside diameter, or higher, in the pipe being televised. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. A reflector in front of the camera shall be capable of showing on the video recording the City name, Contractors name, date, line size and material, line identification (City's manhole numbers at both ends) and ongoing footage counter. The camera, television monitor and other components of the video system shall be capable of producing a picture quality to the satisfaction of the City; and if unsatisfactory the equipment shall be removed and replaced with adequate equipment. No payment will be made for an unsatisfactory inspection.

1. Video Recording

a. A CD or DVD disk shall be supplied for all inspection surveys. All videos shall be performed and submitted at a resolution capable of providing a

picture quality which is adequate for the purpose of inspection as stated in these Specifications and to the satisfaction of the City. All videos shall be submitted to the City in MPEG1 format (mpg.), user friendly and easy to view utilizing standard Windows software and will become the property of the City.

b. Two (2) labels are required. One (1) shall be placed on the CD or DVD and the other on the face of the jewel case. Permanently label each CD or DVD with the following information:

2. Face of the CD or DVD

3. Face of the CD or DVD Jewel Case

Manhole No. From	Manhole No. To	Pipe Diameter	Pipe Length	Street

PART 3 EXECUTION

3.1 WATER USE

Potable water to be used for pipe lining and cleaning processes may be obtained from the City fire hydrants when available, at no cost to the Contractor. If hydrant water is not

available the Contractor must provide other sources of water for the cleaning and lining process at its own expense. The Contractor shall be responsible for obtaining all necessary fire hydrant permits. The Contractor shall provide all piping, hoses, valves, connections, or tank vehicles necessary to complete the Work.

3.2 PRECONSTRUCTION SUBMITTALS

A. At least ten (10) days prior to beginning Work, the Contractor shall submit the following items for the Engineer's approval:

B. A comprehensive construction sequencing plan. At minimum, the plan shall include:

1. A proposed Work schedule.
2. Identification of set-up locations for lining installation.
3. Lining procedures.
4. Bypass pumping plan.
5. Waste and debris disposal plan.

C. Manufacturer's published literature and published data for the proposed cured in place liner system.

D. The cured in place rehabilitation system supplier's letter of certification for each worker who will perform cured in place rehabilitation Work.

E. The manufacturer's certification that the proposed CIPP system for the project meets the requirements of these Specifications will meet or exceed the physical properties given in the manufacturer's published literature submitted as required by Part A of this subsection.

F. Documentation of Product Experience. The Contractor may be required to include references for jobs completed with the proposed CIPP rehabilitation method. The jobs submitted shall show that at least twenty thousand (20,000) linear feet of the product has been installed in similar size diameter pipes by the Contractor or other Contractors. The documentation may include up to ten (10) jobs, which have been completed, preferably within the last two (2) years, and installed in similar size pipe diameters. Information provided for each job shall include a description of the job, the location of the job, the value of the job and the contact for the job including name, title, address and telephone number.

G. Calculations supporting recommended liner thicknesses. The calculations shall be sealed by a registered Professional Engineer licensed in the state of Maryland.

H. Shop drawings and product data for the rehabilitation method including a report outlining the process to be used in the rehabilitation of the sewer line. The report shall also include information specific to the job, such as coordination issues, access, timing, manufacturer's installation instructions and bypass pumping.

3.3 SUBMITTALS PRIOR TO INSTALLING LINER

A. All measurements made by the Contractor to verify length and diameter of pipe prior to ordering of material.

B. Two (2) complete sets of video and audio information from the pre-installation television inspections performed as specified in the television inspection section.

3.4 POST-CONSTRUCTION SUBMITTALS

A. After construction, the Contractor shall submit the following information for review and approval:

1. Material testing results.
2. Two (2) complete sets of video and audio from the post-installation television inspections.

3.5 SEWER PIPE CLEANING

A. General

The intent of sewer pipe cleaning is to remove foreign materials from the sewer as required for the TV inspection and/or proper installation of the CIPP. It is recognized there are some conditions such as broken pipe and major blockages that prevent cleaning from being accomplished or where additional damage would result if cleaning were attempted or continued. The Engineer will evaluate the obstruction and will direct the Contractor as to the amount and method to be used for cleaning those specific pipe sections if cleaning is determined by the Engineer to be feasible. If in the course of normal cleaning operations, damage results from preexisting and/or unforeseen conditions, such as broken pipe, the Contractor will notify the Engineer of the location and nature of the damage. The Contractor will be required to make repairs at no additional cost to the City when the Engineer has determined the Contractor was negligent in performance of its cleaning operations.

B. Cleaning Equipment

1. Hydraulically Propelled Equipment: The equipment used shall be a movable dam type and be constructed in such a way that a portion of the dam may be collapsed at any time during the cleaning operation to protect against flooding of the sewer. The movable dam shall be equal in diameter to the pipe being cleaned and shall provide a flexible scraper around the outer periphery to insure removal of grease. If sewer cleaning balls and other equipment which cannot be collapsed are used, special precautions to prevent flooding of the sewer, public or private property shall be taken.
2. High Velocity Jet (Hydrocleaning) Equipment: All high-velocity sewer light cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two (2) or more high-velocity nozzles. The nozzles shall be capable of producing a scouring action from fifteen to forty-five degrees (15° to 45°) in all size lines designated to be cleaned.
3. Equipment shall also include a high-velocity gun for washing and scouring manhole walls and floors. The gun shall be capable of producing flows from a fine mist to a solid stream. The equipment shall carry its own water tank, auxiliary engines, pumps and hydraulically driven hose reel.
4. Mechanically Powered Equipment

    a. Bucket machines shall be in pairs with sufficient power to perform the Work in an efficient manner. Machines shall be belt operated or have an

overload device. Machines with direct drive that could cause damage to the sewer will not be allowed.

b. Power rodding machines shall be either sectional or continuous rod type, capable of holding a minimum of seven hundred fifty feet (750') of rod. The rod will be fabricated of a heat treated steel.

5. Satisfactory precautions shall be taken to protect the sewer lines from damage that might be inflicted by the improper use of cleaning equipment. Sewer damage as a result of the Contractor's improper operations shall be promptly repaired by the Contractor at no cost to the City. All equipment, devices and tools required for the cleaning operation shall be owned or leased and operated by the Contractor.

C. Sewer Cleaning

The designated sewer section shall be cleaned using hydraulically propelled, high velocity jet equipment or mechanically powered equipment. The equipment shall be capable of removing dirt, grease, rock, sand, other materials and obstructions from the sewer lines and manholes. The equipment and methods selected shall be approved by the Engineer. If cleaning of an entire sewer cannot be successfully performed from one (1) manhole, the equipment shall be set up on the other manhole and cleaning again attempted.

D. Root Removal

1. Roots shall be removed in sections where root intrusion is a problem. Any roots which could prevent the proper insertion of the CIPP shall be removed. Root removal techniques may include use of mechanical equipment such as rodding machines, bucket machines or winches using root cutters and porcupines. Equipment such as high-velocity jet cleaners or chemical root treatment may be used at the Contractor's option and in accordance with the manufacturer's Specifications.
2. To aid in removal of roots, sewer sections that have root intrusion shall be treated with an acceptable herbicide. The application of the herbicide to the roots shall be done in accordance with the manufacturer's recommendations and Specifications in such a manner to preclude damage to surrounding vegetation. Any damaged vegetation so designated by the City shall be replaced by the Contractor at no additional cost to the City. All safety precautions as recommended by the manufacturer shall be adhered to concerning handling and application of the herbicide.

E. Cleaning Precautions

1. During all cleaning and preparation operations, all necessary precautions shall be taken to protect the sewer from damage and to insure that no damage is caused to property adjacent to or served by the sewer or its branches. Any damage caused to property as a result of such cleaning and preparation operations shall be restored to preexisting conditions by the Contractor at no additional cost to the City. Satisfactory precautions shall be taken in the use of cleaning equipment.
2. When hydraulically propelled cleaning tools (which depend upon water pressure to provide their cleaning force) or tools which retard the flow in the sewer line are used, precautions shall be taken to ensure that the water pressure created does not damage or cause flooding of property being served by the sewer. When

possible, the flow if sewage in the sewer shall be utilized to provide the necessary pressure for hydraulic cleaning devices. When additional water from fire hydrants is necessary to avoid delay in normal work procedures, the water shall be conserved and not used unnecessarily. No fire hydrant shall be obstructed in case of fire in the area served by the hydrant.

F. Material Removal and Disposal

1. All loose debris and other solid or semisolid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. When hydraulic cleaning equipment is used a suitable dam or weir shall be placed in the downstream manhole to trap all such material. Passing material from the manhole section to manhole section, which could cause line stoppage, accumulation of sand in wet wells, or damage pumping equipment, shall not be permitted.
2. Under no circumstances shall any loose debris removed during these operations be dumped or spilled into streets, ditches, storm drains or other sanitary sewers. All solids or semisolids resulting from the cleaning operations shall be removed from the site and disposed of by the Contractor, at its expense, no less often than the end of each workday, in a legal and sanitary manner as approved by the appropriate authorities, in a properly licensed landfill. Under no circumstances will the Contractor be allowed to accumulate debris, etc, on the site of Work beyond the stated time, except on totally enclosed containers and as acceptable to the City.
3. The Contractor shall keep its haul route and work area(s) neat, clean and reasonably free of odor, and shall bear all responsibility for the clean up of any spill which occurs during the transport of cleaning/surface preparation by-products and the cleanup of any such material which is authorized by or pursuant to the Contract and in accordance with applicable law and regulations. The Contractor shall immediately cleanup any such spill or waste. If the Contractor fails to clean up such spill or waste immediately, the City shall have the right to clean up or arrange for its clean up, and shall charge to the Contractor all costs, including administrative costs and overhead, incurred by the City in connection with the clean up. The City shall also charge to the Contractor any costs incurred or penalties imposed on the City as a result of any spill, dump or discard. Under no circumstances is this material to be discharged into the waterways or any place other than where authorized to do so by the appropriate authorities.
4. The general requirements for vehicles hauling such material are as follows: Transport vehicles must be of type(s) approved for this application by the political jurisdiction involved, that they have water tight bodies, that they are properly equipped and fitted with seals and covers to prohibit material spillage or drainage, and that they be cleaned as often as is necessary to prevent deposit of material on roadways. Vehicles must be loaded within legal weight limits and operated safely within all traffic speed regulations.
5. The routs used by the Contractor for the conveyance of this material on a regular basis shall be subject to approval by governing authority having jurisdiction over such routs.

G. Acceptance of Sewer Cleaning

1. Acceptance of sewer cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the City. The Contractor shall

be required to reclean and reinspect the sewer line until the cleaning is shown to be satisfactory. In areas where television inspection is not possible, the City may require the Contractor to pull a double squeegee (with each squeegee the same diameter as the sewer) through each sewer section as evidence of adequate cleaning.

2. In addition, on all sewer lines which have sags or dips, to an extent that the television camera lens becomes submerged for three (3) or more feet during television inspection, the Contractor shall pull double squeegee and/or sponges through the line in order to remove the water from the dip or sag or until television camera lens is no longer submerged. This requirement may be waived by the City if the water in which the camera lens is submerged is clear enough to allow the identification of pipe defects, cracks, holes and location of service taps or branch sewers.

3.6 BYPASS PUMPING

A. The Contractor shall provide all pumps, piping and other equipment necessary to accomplish bypass pumping around the manhole and/or sewer section; perform all construction and obtain all permits necessary for bypass pumping operations.

B. The Contractor shall bypass all flows around the sections of line that are to be rehabilitated. The Contractor shall schedule the Work during dry weather conditions. The bypass shall be made by plugging an existing upstream manhole, if necessary, and pumping the flow into a downstream manhole or adjacent system. The pump and bypass line shall be of adequate size and capacity to handle the flow. Contractor shall perform all Work during dry weather flow periods and provide to the Engineer a schedule and plan for conducting bypass pumping operations of sewage flow. Pumping schemes are subject to the Engineer's approval.

C. When the depth of flow in the sewer line being televised or repaired is above the maximum allowable for the proposed Work (as specified in the following paragraph C), then the Contractor shall reduce the flow to the level shown below by manual operation of pump stations, plugging or blocking of the flow, or by pumping and bypassing of the flow as acceptable to the Engineer. Plugging or blocking of the flow shall only be allowed when the Contractor can demonstrate that the upstream gravity collection system can accommodate the surcharging without any adverse impact.

D. The depth of flow in the sewer line being televised or repaired shall not exceed that shown below for the respective pipe size and for the operation indicated.

1. Maximum depth of flow for television inspection:

a	6″–10″ pipe:	20% of pipe diameter
b.	12″–24″ pipe:	25% of pipe diameter
c.	27″ or greater:	30% of pipe diameter

2. For pipe lining installation, pipe replacement or pipe repair, the sewer line shall be blocked completely. No flow or flow depth, except infiltration, will be allowed through the sewer line.

3. Violations from sewage spills shall be the sole responsibility of the Contractor and it is the Contractor's responsibility to immediately report all sewage spills or overflows resulting from construction activity to the Engineer.
4. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

E. Inspection and Installation

1. Preparation

a. The Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipeline and shall locate its bypass pipeline to minimize any disturbance to existing utilities. Contractor shall obtain approval of the pipeline from the City. All costs associated with relocating utilities and obtaining all approvals shall be paid by the Contractor.
b. When working inside a manhole or force main, the Contractor shall exercise caution and comply with OSHA requirements when working in the presence of sewer gases, combustible or oxygen deficient atmospheres and confined spaces.
c. The installation of the bypass pipelines is prohibited in all wetland areas. The Contractor is responsible for obtaining approvals for placement of the temporary pipeline within public ways from the Maryland DOT and the City of Baltimore DOT.

F. Plugging and Blocking

A sewer line plug shall be inserted into the line upstream from the section being televised or repaired and shall be so designed that all or any portion of the upstream flow can be released. During the television inspections and repair operations, the flow through the line shall be reduced to within the maximum limits stated above. After the Work has been completed, the flow shall be restored to normal.

G. Pumping and Bypassing

1. When pumping and bypass pumping is required, as determined by the Engineer, the Contractor shall supply all necessary pumps, conduit and other equipment to divert the flow around the manhole section in which the Work is to be performed. The bypass system shall be of sufficient capacity to handle existing plus additional flow that may occur during rainstorm events. The Contractor shall be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypass system. Pumps and equipment shall be continuously monitored by the Contractor during the period that the pumping and bypassing are required. Engines shall be equipped in a manner to keep noise to a minimum.
2. The Contractor shall select pumping and bypassing equipment that will not have excess noise levels (silenced type pumps) and shall be restricted to a maximum of eighty decibels (80 dB) at a distance of fifty feet (50′).

H. Flow Control Precautions

1. When flow in a sewer line is plugged, blocked or bypassed by the Contractor, it shall take sufficient precautions to protect the public health and to protect the sewer lines

from damage that might result from sewer surcharging. Further, the Contractor shall take precautions to insure the sewer flow control operations do not cause flooding or damage to public or privet property being served by the sewers involved. The Contractor shall be responsible for any damage resulting from its flow control operations. Any liquid or solid matter, which is bypass pumped from the sewer collection system, shall be discharged to another sewer manhole or appropriate vehicle or container only. No such liquid or solid matter shall be allowed to be discharged, stored or deposited to the open environment. The Contractor shall protect all pumps, conduits and other equipment used for bypass from traffic.

2. When flow in a sewer line is plugged, blocked or bypassed by the Contractor, it shall monitor the conditions upstream of the plug and shall be prepared to immediately start bypass pumping if needed.
3. Should any liquid or solid matter from the sewer collection system be spilled, discharged, leaked or otherwise deposited to the open environment as a result of the Contractor's flow control operations, it shall be responsible for all clean up and disinfection of the affected area and all costs associated with same. The Contractor shall also be responsible for immediately notifying the sewer system operating personnel and performing all required clean up operations at no additional charge to the City.

3.7 TELEVISION INSPECTION METHODS

A. Pre-installation Inspection

1. Procedure

   a. Perform pre-installation TV inspection immediately after line cleaning and before line rehabilitation Work. Pre-installation TV inspection is not required for sewer lines designated as remove and replace. Verify that the line is clean and ready to accept the line rehabilitation. Prepare Television Inspection Logs. Maintain copies of CD/DVD and report for reference by the City for the duration of the project.

   b. Prior to any repair Work, the entire sewer line (from manhole to manhole) shall be televised. The pre-installation inspection shall be used to determine whether the line has been cleaned sufficiently; to confirm the location and nature of defects and confirm the proposed method of repair is proper for the defects observed.

   c. The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. In no case will the television camera be pulled at a speed greater than thirty feet (30') per minute. Manual winches, power winches, TV cable, powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer condition shall be used to move the camera through the sewer line.

   d. If during the inspection operation the television camera will not pass through the entire sewer section, the Contractor shall set up its equipment so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire pipe section, the inspection shall be considered complete and no additional inspection will be required at that time. Improper cleaning will not be a reason for incomplete televising of a line section.

e. When manually operated winches are used to pull the television camera through the line, telephones or other suitable means of communications shall be set up between the two (2) manholes of the section being inspected to ensure good communications between members of the crew.

f. The importance of accurate distance measurements is emphasized. Measurements for location of defects shall be above ground by means of a meter device. Marking on the cable, or the like, which would require interpolation of depth of manhole, will not be allowed. Accuracy of the distance meter shall be checked by the use of a walking meter, roll a tape or other suitable device. The meter device shall be accurate to tenths of a foot.

g. During the internal inspection, the television camera shall be temporarily stopped at each defect along the line. The nature and location of the defect shall be recorded by the Contractor. Where defects are also active infiltration sources, the rate of infiltration in gallons per minute shall be estimated by the Contractor and recorded. The camera shall also be stopped at active service connections where flow is discharging. If the flow continues, the property involved shall be checked by the Contractor to determine whether or not the flow is sewage. Flows from service connections which are determined to be infiltration shall also be recorded.

h. Camera operator shall slowly pan beginning and ending manholes, each service connection, clamped joints, and when pipe material transitions from one material to another.

i. TV inspection CD/DVD shall be continuous for pipe segments between manholes. Do not leave gaps in the video recording of a segment between manholes and do not show a single segment on more than one (1) videotape, unless specifically allowed by the City.

2. Flow Control

a. Perform survey TV inspection on one (1) manhole section at a time.

b. If during survey TV inspection of a manhole section, the wastewater flow depth exceeds the above allowable depths of the inside pipe diameter, reduce the flow depth to an acceptable level by performing the survey TV inspection during minimum flow hours, bypass pumping, plugging or by pulling the camera with swab, high-velocity jet nozzle or other acceptable dewatering device. Video inspection recordings made while floating the camera is not acceptable unless approved by the City.

B. Documentation of Television Inspection

1. Television Inspection Logs: Printed location records shall be kept by the Contractor and will clearly show the location in relation to an adjacent manhole of each infiltration point observed during inspection. In addition, other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, broken pipe, presence of scale and corrosion, and other discernible features will be recorded and a copy of such records will be supplied to the City.

2. Digital Photographs: Noted defects and lateral connections shall be documented as digital files and hard copy printouts.

3. Video Recordings: The purpose of CD/DVD recording shall be to supply a visual and audio record of problem areas of the lines that may be replayed. Video recordings shall include an audio track recorded by the inspection technician

during the actual inspection Work describing the parameters of the line being inspected (i.e., location, depth, diameter, pipe material), as well as describing connections, defects and unusual conditions observed during the inspection. Video recording playback shall be at the same speed that it was recorded. Slow motion or stop motion playback features may be supplied at the option of the Contractor. The CD/DVD shall be labeled and become the property of the City. The Contractor shall have all CD/DVD and necessary playback equipment readily accessible for review by the City during the project.

C. Post-Installation TV Inspection

1. Procedure

a. Post-Installation TV inspection shall not be completed until all Work, including lateral replacement and/or reactivation, manhole restoration is complete on a section of line. The post-installation TV inspection CD/DVD shall be submitted to the City prior to substantial completion, or when requested.

b. The post-installation TV inspection shall be completed to confirm completion of rehabilitation and replacement Work, including removal and replacement. Verify that the rehabilitation Work conforms to the requirements of the Drawings and Specifications. Provide a color video CD/DVD showing the completed Work, including the condition of restored service connections. Prepare and submit Television Inspection Logs providing location of service connections along with location of any discrepancies. Manhole Work, including benches, inverts and pipe penetrations into manhole, should be complete prior to post-installation TV Work.

c. For post-installation TV inspection, exercise the full capabilities of the camera equipment to document the completion of the rehabilitation and replacement Work and the conformance of the Work to the Drawings and Specifications. Provide a full three-hundred sixty-five (365) degree view of pipe, joints, and service connections.

d. Flow Control and Documentation of Television Inspection shall be conducted as specified in the Pre-Installation Inspection Procedure of this Specification section.

3.8 CIPP LINING INSPECTION AND INSTALLATION

A. Prior to beginning insertion of the liner bag, the Contractor shall inspect the cleaned line by use of closed circuit TV cameras and shall confirm to its own satisfaction that the lines are adequately cleaned. Insertion of the bag by the Contractor shall serve as evidence of its acceptance of the condition of the piping and the suitability of the liner insertion within the host pipe. Failure of the liner system due to inadequately cleaned host pipes shall be repaired by the Contractor at no cost to the City.

B. During the process of manufacture and impregnation, the City shall have reasonable opportunity to examine all operations where the manufacture and impregnation (when applicable) of the liner is being carried out. The Contractor shall give appropriate prior notice in order that the Engineer may be on hand to observe the various processes.

C. No Work shall be performed by the Contractor except in the presence of the Engineer, unless otherwise approved. The Contractor shall coordinate its work schedule and give timely prior notice regarding its intentions to perform any and/or all parts of the Work, in order that the Engineer may be on hand. Any Work performed in the absence of the Engineer is subject to removal and replacement at the Contractor's expense.

D. Upon substantial completion of the Work the Contractor shall, in the presence of the Engineer, inspect the line using closed circuit television equipment. The video produced shall be accompanied by a simultaneously produced, audio narration. The audio narration shall draw attention to all recognizable defects, imperfections, etc., and the location along the length of the piping shall be accurately noted. In addition, the locations and all pertinent details regarding the entrance of service laterals into the main trunk sewer shall be accurately noted on the audio narration. One (1) copy of the audio and video information shall become the property of the City. Televising shall be performed as specified in the television inspection section.

3.9 PREPARATORY PROCEDURES

A. In order to minimize the inconvenience to the property owners, the Work shall be limited to two (2) sections of sewer at a time, unless otherwise permitted by the Engineer. A section of sewer shall mean from manhole to manhole. The Contractor shall schedule the actual liner installation to begin forty-eight (48) hours after residents whose service laterals are connected to the sewer segment have been notified of the water shutdown and the impending Work. The City will be responsible for the notification and the shutting down of water services to residents whose service laterals are connected to those sewer segments to be lined. The duration of shutdown shall be subject to the approval of the Engineer.

B. The Contractor shall be responsible for the construction layout at the beginning of the project. The Contractor shall take all precautions to protect all stakes, hubs, control points, etc. If the stakes, hubs, control points, etc. are disturbed during construction, the Contractor shall restake at its expense. The Contractor is responsible for the accuracy of the restaking.

C. The utilities must be marked by "Miss Utility" prior to construction layout.

D. The sizes, lengths and materials of the pipes to be relined shall be as indicated on the plans, but shall be verified by the Contractor prior to commencing with the Work.

E. Cleaning: Cleaning of sewer lines shall be performed as specified in the sewer line cleaning section.

F. TV Inspection: Inspection of sewer lines shall be performed as specified in the television inspection section.

G. Bypass Pumping: Bypass pumping of sewer lines shall be performed as specified in the bypass pumping section.

H. Obstruction Removal: The sewer line shall be cleared of obstructions such as solids, dropped joints, intruding service connections or collapsed pipe that may prevent liner installation. If inspection reveals an obstruction that cannot be removed by conventional remote sewer equipment, then a point repair excavation shall be made to remove or repair

the obstruction. NOTE: Point repairs shall be made only after cleaning methods were performed and shall be approved in advance by the Engineer.

I. Root Removal: Refer to 3.5, D of the sewer line cleaning section.

J. Material Removal: Refer to 3.5, F of the sewer line cleaning section.

K. Disposal of Materials: Refer to 3.5, F of the sewer line cleaning section.

3.10 LINING PROCEDURES

A. Conduct operations in accordance with applicable OSHA standards, including those safety requirements involving Work on an elevated platform and entry into a confined space. Make suitable precautions to eliminate hazards to personnel near construction activities when pressurized air is being used.

B. In the event of insertion being delayed after impregnation by unexpected site conditions but prior to the start of the insertion process, the Contractor shall store, at its own cost, the liner, for a further period of at least forty-eight (48) hours, below thirty-nine degrees (39°) F for use when conditions allow.

C. The liner shall be inverted into the pipeline from a suitable platform located above the manhole or other approved point of inversion. The Contractor shall be allowed to insert the liner using another process approved by the Engineer. The free open end of the liner bag shall be firmly secured to the platform and the folded liner passed down a suitably reinforced column to a chute or bend leading to the opening of the pipe to be lined. Clean water at ambient temperature shall be supplied to the platform at a rate sufficient to cause controlled installation of the liner into the pipeline.

D. Liner inversion rate shall not exceed thirty-two feet (32') per minute and the tail of the liner or the tail tag rope shall be suitably restrained to prevent liner run away, if applicable.

E. The Contractor shall supply a suitable heat source and recirculation equipment capable of delivering required curing temperature to the far end of the liner to quickly and uniformly raise the water temperature in the entire liner, once inverted in the pipeline, above the temperature required to commence the exothermic reaction of the resin as determined by the catalyst system employed.

F. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply to determine when uniform temperature is achieved throughout the length of the liner. Another such gage shall be placed between the impregnated tube and the pipe invert at the termination to determine the temperatures during cure.

G. Initial cure will occur during temperature heat up and shall be completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exothermic or cure in the resin. After initial cure is reached, the temperature shall be raised to the post-cure temperature recommended by the resin manufacturer. The post-cure temperature shall be held for a period as recommended by the resin manufacturer, during which time the recirculation of the water and cycling of the boiler to maintain the temperature shall continue. The curing of the

CIPP must take into account the existing pipe material, the resin system and ground conditions (temperature, moisture level, and thermal conductivity of soil).

H. The curing period shall be carried out under an inversion head to maintain a minimum hoop tension in the liner felt of one (1) lb/ sq. in.

I. Maintain a curing log of CIPP temperatures at the upstream and downstream manholes during the curing process to document proper temperatures and cure times have been achieved.

J. Invert through Manholes. The invert shall be continuous and smooth through all manholes. If a liner is installed through a manhole, the bottom portion of the liner shall remain and the bench of the manhole shall be grouted and shaped as necessary to support the liner. If the liner terminates on either side of a manhole, the invert shall be built up to remove any flow restrictions and to form a continuous invert through the manhole. The cost of this Work shall be included in the unit price Bid for the liner.

K. The finished pipelining shall be continuous over the entire length of an insertion run between two (2) manholes or structures and be as free as commercially practical from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes, dimples and delamination. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe.

L. The inner surface shall be free of cracks and crazing with smooth finish and with an average of not over two (2) pits per twelve inch (12″) square, providing the pits are less than twelve-one-hundredths of an inch (0.12″) in diameter and not over four-one-hundredths of an inch (0.04″) deep and are covered with sufficient resin to avoid exposure of the inner fabric. Some minor waviness and wrinkles, that in the City's opinion will not appreciably decrease the flow characteristics or be the cause of a possible blockage, shall be permissible.

3.11 SEALING AT MANHOLES

Form a tight seal between the CIPP and the host pipe at the pipe penetration. Do not leave any annular gaps or routes of infiltration. Seal the annular space with a one half inch (1/2″) diameter activated Oakum band soaked in chemical sealant or an approved equivalent. Seal any annular spaces greater than one-half inch (1/2″) with manhole wall repair material. Finish off the seal with a nonshrink grout or cementitious liner material approved by the engineer and placed around the pipe opening from inside the manhole in a band at least four inches (4″) wide. Complete the sealing procedure for each liner segment immediately after the liner is cured.

3.12 DEFECTIVE WORK

Any defects, which, in the judgment of the City, will affect the integrity or strength of the lining, shall be repaired or the liner replaced at the Contractor's expense. Obtain approval of the Engineer for method of repair, which may require field or workshop demonstration.

3.13 REESTABLISHING CONNECTIONS

Refer to 33 31 13.02, (Reestablishing Sewer Connections after Rehabilitation) and the following:

A. The Contractor shall open all sewer house connections located and identified from the CIPP television inspections.

B. Cutting the holes to reestablish the sewer house connections shall be accomplished from the interior of the pipe by means of a remote television camera directed cutting device.

C. Holes cut through the CIPP shall be neat and smooth and shall be free of burrs, frayed edges, or any restrictions preventing free flow into the main line sewer. Sewer house connections shall be reestablished to a minimum of ninety percent (90%) of the original opening. All "coupons" and fragments of "coupons" resulting from cutting the CIPP shall be recovered at the downstream manhole and removed. All edges shall be brushed smooth.

D. Acceptance of the reestablished connections will be subject to approval of the Engineer. Approval will be based upon review of the post-rehabilitation television inspection of the CIPP.

3.14 SEALING SEWER HOUSE CONNECTIONS

The Contractor shall stop all visible leaks at the reestablished sewer house connection. Contractor shall submit method and equipment for sealing leaks for approval by the Engineer. Any sealing method required shall be at the Contractor's expense.

3.15 CIPP TESTING

A. The Contractor shall collect a coupon sample/specimen from each pipe diameter as described below. The Contractor shall stamp or mark the test pieces with the date of manufacture and batch number.

B. Should the City desire to make additional independent tests, the Contractor shall, upon request of the City, furnish any reasonable number of test pieces of raw material samples as the City may require, stamped or marked with the date of manufacture and batch number if applicable.

C. Tests shall be made on specimens of resin, catalyst and felt as supplied or pieces of cured liner cut from waste areas when possible. Otherwise, the specimens shall be cut from a piece of cured liner representative of the material inserted and prepared and cured in a similar technique to the process employed.

D. The test specimen shall be conditioned in accordance with procedure "A" of ASTM Designation D 618-61, Standard Methods for Conditioning Plastics and Electrical Materials for Testing.

E. The test specimen shall be prepared and physical properties tested in accordance with ASTM F 1216, Section 8.1. The properties shall meet or exceed the values identified in Table 1 of ASTM F 1216.

F. The Contractor shall in preparation for insertion of the liner bag and in placing of stops within the terminal manholes of an insertion run, allow sufficient length to facilitate the cutting out of one (1) full size cured liner section, for each thickness of liner installed, from the waste portion at the end of an insertion run. The lengths of the full size section thus provided shall be as practical, in order to facilitate load testing if desired by the City.

3.16 FINAL ACCEPTANCE OF CIPP

Upon completion and before acceptance by the City, the Contractor shall reinspect the rehabilitated pipeline by the use of closed circuit TV cameras and shall submit video of the rehabilitated pipeline to the Engineer for approval/acceptance of the Work in accordance with the television inspection section.

3.17 FINAL CLEANUP

Upon completion of rehabilitation Work and testing, clean and restore project area affected by the Work.

PART 4 MEASUREMENT AND PAYMENT

A. CIPP will be measured and paid for at the Contract Unit Price per linear foot and the quantity to be paid for will be the number of linear feet of liner actually installed and accepted by the Engineer. Measurement shall be along the centerline of pipe from end to end at the inside face of wall at the manholes. The payment shall be full compensation for all material, labor, equipment, tools, hauling, bypass pumping, cleaning, root removal,

B. Reestablishing sewer house connections will be measured and paid for at the Contract Unit Price Bid per each for each sewer house connection reestablished; which payment will be full compensation for all labor, material, equipment, tools, sealing laterals where necessary and incidentals necessary to complete the Work.

33 31 13.02 REESTABLISHING SEWER HOUSE CONNECTIONS AFTER REHABILITATING MAIN LINE SEWER WITH CURED-IN-PLACE PIPE (CIPP)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of reestablishing sewer house connections after rehabilitating main line sewer with CIPP.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

3.1 REESTABLISHING SEWER HOUSE CONNECTIONS

A. The Contractor shall open all sewer house connections located and identified from the CIPP television inspections.

B. Cutting the holes to reestablish the sewer house connections shall be accomplished from the interior of the pipe by means of a remote television camera directed cutting device.

C. Holes cut through the CIPP shall be neat and smooth and shall be free of burrs, frayed edges, or any restrictions preventing free flow into the main line sewer. Sewer house connections shall be reestablished to a minimum of ninety percent (90%) of the original opening. All "coupons" and fragments of "coupons" resulting from cutting the CIPP shall be recovered at the downstream manhole and removed. All edges shall be brushed smooth.

D. Acceptance of the reestablished connections will be subject to approval of the Engineer. Approval will be based upon review of the post-rehabilitation television inspection of the CIPP.

3.2 SEALING SEWER HOUSE CONNECTIONS

The Contractor shall stop all visible leaks at the reestablished sewer house connection. Contractor shall submit method and equipment for sealing leaks for approval by the Engineer. Any sealing method required shall be at the Contractor's expense.

PART 4 MEASUREMENT AND PAYMENT

Reestablishing sewer house connections will be measured and paid for at the Contract Unit Price Bid per each for each sewer house connection reestablished; which payment will be full compensation for all labor, material, equipment, tools, sealing laterals where necessary and incidentals necessary to complete the Work.

33 39 00 SANITARY UTILITY SEWERAGE STRUCTURES

33 39 13 SANITARY UTILITY SEWERAGE MANHOLES, MISCELLANEOUS STRUCTURES, FRAMES AND COVERS

PART 1 GENERAL

1.1 DESCRIPTION

Work consists of excavation, backfill and compaction beyond trench pay limits, furnishing and placing manholes complete, either over existing or new sewers, including concrete base and manhole frames and covers. Manhole risers shall be constructed of precast concrete elements or brick masonry built to the shapes and dimensions shown and in accordance with the Contract Documents and Standard Details.

PART 2 PRODUCTS

2.2 MATERIALS

A. Mortar: Joint and parging mortar for manhole brick Work shall consist of one (1) part Type II Portland cement and two and one-quarter (2-1/4) parts fine aggregate, per 03 30 00, Part 2.1 C, (Portland Cement Concrete Structures), by volume and sufficient water to make a stiff mix. Lime in mortar is prohibited.

B. Curing materials shall conform to 03 30 00, Part 2.1 A, (Portland Cement Concrete Structures).

C. Concrete Mix No. 1, 2, No. 3 or No. 6: Shall conform to 03 30 00, Part 2.1 G, (Portland Cement Concrete Structures).

D. Grout shall conform to 03 30 00, Part 2.1 H, (Portland Cement Concrete Structures).

E. Brick used for sewer channel lining shall be shall conform to M 91, Grade SS. All other brick utilized in sewer structures and manholes shall be manhole brick, Grade MS. Brick shall be two and one-quarter inch by three and three-quarter inch by eight inch (2-1/4″ X 3 3/4″ X 8″) in size.

F. Reinforcement steel shall conform to 03 30 00, Part 2.1 K, (Portland Cement Concrete Structures.

G. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

H. Castings for Frames, Covers, and Steps: Iron castings shall conform to A 48, Class 30B. Covers shall be labeled in accordance with the Standard Details. Steps and ladders shall be as dimensioned on the Standard Details. Manhole steps shall conform to A 312 Grade TP 410 Stainless steel or shall be reinforced plastic steps composed of ASTM A615, Grade 60 reinforcing bar (#4) completely encapsulated in copolymer polypropylene per ASTM D2146, Type II, Grade 43758. Manholes designated in Contract documents to be fitted with "lock type" frame and cover, ventilating or pressure type shall be furnished with heavy duty cast iron frames, and corresponding covers with a minimum of four (4) counter-sunk bronze hexagonal head cap screws and concealed pickholes. Ventilating type shall have a rubber gasket seal.

I. Zinc coating shall conform to A 153.

J. Stone beneath manhole bases shall conform to M 43 Size No. 57.

K. Precast Concrete manholes, grade rings shall conform to ASTM C478. Mix Number shall be as indicated on the Standard Details or the Plans.

L. "0" ring compression seals for precast sewer manhole risers shall be per ASTM C443. Risers shall be cast with joint groove to receive "O" ring compression seal.

M. Waterproofing for exterior of manholes and miscellaneous structures shall be as specified in the Contract Documents and 03 15 13, Part 2.1, (Dampproofing and Waterproofing).

N. Manhole to Pipeline Connectors: Unless otherwise indicated in the Contract Documents, flexible gasket connectors for connecting pipes to manholes shall meet the requirements of ASTM C923.

O. Flexible plastic gaskets between the manhole or grade rings and the manhole frame shall be extruded rope, type B, three-quarters inch (3/4″) minimum diameter, butyl based, meeting requirements of AASHTO M 198.

PART 3 EXECUTION

3.1 GENERAL

A. Refer to 03 30 00, (Portland Cement Concrete Structures), 04 21 13, (Brick Masonry) and 33 05 16.13, (Precast Concrete Utility Structures).

B. Excavation for manholes over all sewers shall be extended as needed beyond trench limits, and the excavation shall be maintained and shored as necessary for proper construction. After the manhole is complete and concrete and parging have cured, the remaining excavation shall be backfilled; the portion of backfill beyond trench limits shall be included as part of Sewer Manhole Work. For manholes over existing sewers, all excavation shall be included as part of Sewer Manhole Work. Excavation, foundation preparation, backfill, and compaction shall be as specified in 31 23 33, (Trenching and Backfilling).

3.2 CONSTRUCTION SEQUENCE

Underground sanitary sewer structures shall be completed before roadway surfacing is placed. Manholes shall not be completed to final grade until the grading has been finished and all necessary arrangements have been made to ensure suitable connections and tie ins at proper grade and alignment with pavements.

3.3 CASTINGS

A. Frames for manhole covers, shall be set in full beds of mortar and rigidly secured in place to proper grade and alignment as specified in the Contract Documents. Adjust the frame to proper grade by using precast concrete grade rings or brick masonry when structure is in space dedicated for public use, traveled way or when designated to meet existing grade. Transition shall be a minimum of four inches (4″) and a maximum of eighteen inches (18″) high. Otherwise precast structures shall be built without transition. Frames shall be adjusted to within five-thousandths of a foot (0.05′) of surface in existing paved areas and within one-tenths of a foot (0.10′) of the approved surface grade in future paved areas.

B The covers etc., shall fit neatly into their respective frames; and that all similar sized frames or covers be completely interchangeable. Covers will not be permitted to rock in the frame and sufficient metal shall be provided in pouring the casting so that all blisters or imperfections are removed by grinding or machining or bearing surfaces as indicated on the Contract Drawings. The top surface of rims of cover and frames shall be flush when installed. Frames and/or covers shall be shipped to the project site in matched sets and installed in the same manner.

C. The frame shall be set as specified hereinafter:

1. Brick Masonry Transition

a. Prior to placing brick transition, install anchor rods in the bolt inserts and align to pass through the bolt holes in the flange of the manhole frame. When bolt slot inserts are used align as stated above then fill and pack mortar in bolt slot insets and around the anchor rods.

b. The exterior of the brick shall be parged with mortar applied in two (2) coats, each one-quarter to three-eighths inch (1/4″ to 3/8″) thick. Each parge coat shall have curing compound applied and cured for a minimum of sixteen (16)

hours. Parging shall extend a minimum of six inches (6″) below top of cone section and cover the top of the brick to the interior face of the manhole wall. A bed of mortar not to exceed one inch (1″) in thickness may be added to the top of the brick in addition to the parge coats to fine grade the manhole frame and cover with the approved surface grade.

c. After parging has cured, place two (2) rings of flexible gasket on the brick transition so one (1) ring will be under and near the inside and the other under and near the outside of the frame flange. Place frame and bolt in place. Apply two (2) coats of asphalt base waterproofing to the parged area. Waterproof coating shall extend two inches (2″) below parging on the cone section and cover the flange of the frame including anchor rods and nuts. Protect waterproof coating from direct sunlight by backfilling or other acceptable means after it has time to dry.

2. Precast Concrete Grade Ring Transition

a. Provide precast concrete grade rings, three inches (3″) through six inches (6″) thick and sloped grade rings where applicable. If required to meet proper grade, one (1) split grade ring, two inches (2″) thick, may be used provided this does not exceed the maximum transition heights.

1) Prior to placing precast concrete grade rings, install anchor rods in the bolt inserts and align to pass through the bolt holes in the flange of the manhole frame. When bolt slot inserts are used, align as stated above then fill and pack mortar in bolt slots inserts and around the anchor rods.

2) Precast concrete grade rings shall be set in full beds of Type M mortar not less than one-quarter inch (1/4″) nor more than one and one-quarter inch (1-1/4″) thick. During the months of April through November inclusive, we grade rings and the top of the cone section immediately before placing mortar. Mortar mix water shall consist of three (3) parts water to one (1) part mortar bonding admixture. Horizontal circumferential and vertical mortar joints, inside and outside, shall be pointed the full width. Depth of pointing shall not exceed three-eighths of an inch (3/8″). The annular space between the anchor rods and bolt holes shall be filled and packed with mortar on the top ring and finished flush with the ring surface. Apply curing compound to mortar joints inside and outside of manhole wall. The mortar shall be cured a minimum of twenty-four (24) hours prior to backfilling and the setting of the manhole frame.

3) After the mortar has cured, place two (2) rings of flexible gasket on the precast concrete ring so one (1) ring will be under and near the inside and the other under and near the outside of the frame flange. Place frame and bolt in place.

3. Frame and Cover Placement Without Transition

Before placing manhole frame and cover on the precast cone, without transition, install anchor rods in the bolt inserts and align to pass through the bolt holes in the flange of the manhole frame. When bolt slot inserts are used, align as stated above then fill and pack mortar in bolt slot inserts and around the anchor rods. Place two

(2) rings of flexible gasket on the cone top so one (1) ring will be near the outside of the frame flange. Place frame and bolt in place.

3.4 PIPE CONNECTIONS

Inlet and outlet pipes at sanitary sewer structures shall be set or cut flush with the inside faces of the structures and shall extend a sufficient distance beyond the outside faces of these walls to provide ample room for making proper connections. Provide a flexible gasket connector in accordance with the Standard Details and the Contract Documents.

3.5 INVERT/CHANNELS

Provide appropriate flow channel/bench in the bottom of structures. The channel width and height shall match the inside diameters of incoming and outgoing pipes, blended to a smooth contour so flows will traverse smoothly between the different pipes in accordance with the Drawings and Standard Details. Brick channel/bench shall be as specified for masonry Work for utilities in 04 21 13, (Brick Masonry). Channels and a one and one-half foot (1.5′) length of pipe with a watertight plug shall be installed in the manhole for future extensions where shown on the Plans or directed by the Engineer.

3.6 SANITARY SEWER STRUCTURES

The sanitary sewer structures shall be backfilled with No. #57 aggregate for a width of one and one-half feet (1.5′) outside of the structure and extend from the bottom of the structure to the subgrade. Construct manholes of precast sections, cast in place concrete, brick and parge in accordance with Standard Details and the Drawings.

3.7 PRECAST SANITARY SEWER STRUCTURES

A. Working Drawings for structures not detailed in the Contract Documents shall be submitted to the Engineer for approval prior to fabrication.

B. Certification: Certification from the manufacturer for each shipment of precast units is required. A copy of the certification shall be delivered to the Engineer and the Contractor with each shipment. One (1) copy shall remain at the plant. The certification shall contain the name and address of the manufacturer, the type of structure, the identification number, the date of manufacture, the date of shipment, a statement indicating conformance with the Specifications, and the signature of the quality control manager. Noted on the unit shall be the station number and designation, the identification number, the name or trademark of the manufacturer, the date manufactured, and a stamp indicating conformance with the Specifications.

C. No precast unit shall be shipped unless it has been tested and is shown to be in full compliance with the Contract Documents. Plant accepted precast sections shall be protected from damage while in storage at the plant, in transit and at the Contract site. They shall be handled with proper size equipment using only appropriate lifting holes or eyes. Joint ends of the sections shall be kept clean and placed on wood blocks, pallets, or other appropriate material, never on the ground. If damage is evident, it shall be repaired or the section rejected, as directed by the Engineer. Thoroughly clean joint surfaces, remove all debris and foreign matter, and keep joint surfaces clean during assembly. Use rubber gasket, mastic or nonshrink mortar to joint the sections.

D. Precast sections shall be installed in accordance with the Manhole Manufacturer's written assembly instructions. After the precast concrete riser joints have been joined, the annular joint space remaining on the inside and outside of the precast concrete riser joints shall be filled with mortar and the inside joint trowelled smooth. Lifting holes are permitted provided PVC or rubber plugs are installed to make manhole watertight after installation. Riser and base sections shall have cast or augured cutouts of the required diameter for connections and outlet pipes; maximum size of cutouts shall be equal to the outside pipe diameter plus four inches (4″). A clearance of at least nine inches (9″) of concrete shall remain between adjacent connection and outlet pipe holes and between riser joints and holes in precast risers and bases. Lesser clearance will be considered only if additional reinforcing steel is provided and details are submitted for approval.

E. Precast sections damaged beyond acceptable repair after plant acceptance and prior to acceptance after installation will be rejected and shall be removed and replaced at no expense to the City. Damage that is repairable shall be repaired by manufacturer in accordance with its recommended repair methods and in the presence of the Engineer.

F. The placement and consolidation of the required bedding under the unit shall be a minimum six inch (6″) of No. #57 aggregate unless otherwise directed by the Engineer.

3.8 MASONRY SANITARY SEWER STRUCTURES

A. Brick sanitary sewer structures shall be constructed in accordance with 04 21 13, (Brick Masonry).

B. Unless otherwise specified, collars for brick curves shall extend along connecting pipes for a distance equal to upper wall thickness of the respective brick curve.

3.9 CONNECTIONS TO EXISTING SANITARY SEWER

A. Certain information is shown on the Drawings relative to existing sanitary sewer pipe, manholes and appurtenances. This information was transferred from existing records and is deemed to be reliable but the City does not warrant or guarantee that the location, dimensions and type of material existing are exactly as shown. Before installing pipe under this Contract, verify by test pits or other means the detailed requirements for making the proposed connection to existing sanitary sewer.

B. Maintaining existing sewage flows during connection to existing sewer is the responsibility of the Contractor. Precautions and methods to prevent sewage backup shall be taken and employed as required. Sewage backup damage and/or clean up required due the Contractor's operations shall be responsibility of the Contractor. Diverted sewage shall be returned to the sanitary system and not discharged on surfaces or into streams or storm drains. Provide enclosed bypass flumes equivalent in size to the existing sewer being diverted, when required to maintain and divert sewage around connections to existing sewers. Bypass pumping may be used at the Contractor's option for flow diversion as required to prevent sewage backup. Provide and operate pumps, hoses, conduits and other equipment of adequate capacity to prevent back ups. In no case will bypass pumping be permitted at times other than during actual hours of work. Raw sewage spills caused by the Contractor's operation shall be cleaned and disinfected immediately by the Contractor using methods and disinfectants as directed by the Engineer. When Working on an existing sewer provide materials, screening devices and take appropriate measures

to keep solid material from entering the sewage flow. Remove and dispose of solid material as required.

C. When connecting a pipe to an existing manhole, the hole in the manhole shall be perimeter drilled with one (1″) inch or larger diameter holes a maximum of five inches (5″) apart circumferentially and center to center. Unless otherwise noted, provide flexible gasket connector for each pipe connection to existing manholes. Seal the connector into the existing manhole with quick setting nonshrink grout. Excavation shall be kept dry and not be backfilled before eight (8) hours have elapsed.

D. Unless otherwise stated in the Contract Documents, manholes built on an existing sewer shall be constructed as per the Standard Details.

3.10 PIPE ENCASEMENT

Pipe encasement shall be as per Standard Details unless otherwise specified.

3.11 MANHOLE INVERT/CHANNEL

Remove and replace invert/channel in existing manhole to redirect sewage flow.

3.12 FIELD TESTING

A. Manholes and other structures will be air vacuum tested for watertightness. Testing is customarily done before backfilling but may be done after backfilling at the Contractor's own risk. Visual inspection after backfilling is also required. Vacuum testing shall be witnessed by the Engineer.

B. Manholes and other structures may be visually inspected by the Engineer for leakage. Any visible leak shall be sealed or resealed until all leakage into the unit is satisfactorily eliminated. Infiltration testing shall be conducted only when the sewers attached to the manholes or other structures are tested in that manner. Testing shall be in accordance with 33 31 00, (Sanitary Utility Sewerage Piping).

C. All sanitary sewer manholes or other related structures shall be required to pass a vacuum test that is witnessed by the Engineer. Sanitary sewer manholes/structures shall have ten inches (10″) of mercury applied to the manhole and the time measured for the vacuum to drop from ten inches (10″) to nine inches (9″) of mercury.

D. All Sanitary Sewer Manhole/Structure Vacuum tests shall be performed by the Contractor. The Contractor shall provide all equipment and personnel to perform the required testing. All Sanitary Sewer Manhole/Structure Vacuum testing equipment shall be approved by the Engineer prior to its use. Vacuum testing is recommended to be performed prior to backfilling around the manhole/structure.

E. Vacuum testing times for sanitary sewer structures other than manholes (e.g., grease interceptors, etc.) shall be based on the times nearest to the equivalent manhole volume or as directed by the Engineer.

The following are minimum allowable test times for manhole/structure acceptance at the specified vacuum drop:

Depth of Manhole per (feet)	Time Lapse (seconds) Manhole Diameter (inches)		
	48"	60"	72"
8	14	18	23
10	17	23	28
12	21	28	34
14	25	32	40
16	28	37	45
18	32	41	51
20	35	46	57
22	39	51	62
24	42	55	68
26	46	60	74
28	49	64	80
30	53	69	85

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, concrete, masonry, special or precast units, reinforcement, ladder rungs, drip stones, No. 57 aggregate, underdrain stubs, frames, covers, grade and slope adjustments, backfill and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Standard manholes specified in the Contract Documents will be measured and paid for at the Contract Unit Price per linear foot of vertical depth for each type of unit built to the dimensions shown on the Standard Details, plus any additional vertical depth directed by the Engineer. The base bottom thickness for each unit shall not be included in the measurement. Furnishing and placing pipe stub connections in manholes, and masonry structures shall the incidental to the structure or invert/channel replacement Bid items.

C. The measurement of length of brick curves will be measured on the basis of linear foot of the centerline length of the curve from P.C. to P.T. Payment will be made on the basis of unit price Bid per linear foot, which price shall include cost of collars required to connect curves to adjoining pipes and/or structures.

D. Miscellaneous structures constructed using brick masonry or concrete will be measured and paid for at the Contract Unit Price per cubic yard unless otherwise specified in the Contract Documents.

E. No separate or additional measurement will be made for any precast concrete units, metal or castings used in the construction of any of the items noted above.

F. When an existing sanitary sewer structure is to be removed and replaced with a new sanitary sewer structure in the same location, the cost to remove the existing sanitary sewer structure and a section of the existing pipe will be incidental to the cost of the new sanitary sewer structure.

G. Payment for Replace Manhole Invert/Channel will be made at the Contract Unit Price per each, which price and payment will include removal of existing invert/channel, reshaping new invert/channel, disposal of unusable materials, and all labor, materials, tools, equipment and incidentals needed to complete Work specified.

33 41 00 STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. The storm utility drainage piping shall include, but not necessarily be limited to, furnishing and installing concrete pipes, metal pipes, structural plate pipes and structural plate pipe arch culverts that are composed of curved plates bolted together in the field as specified in the Contract Documents or as directed by the Engineer.

B. This Work shall consist of placing the size and type of concrete pipes, metal pipes, structural plate pipes and structural plate pipe arch culverts on a firm bed to the specified line and grade; including all pipe connections to existing pipes, inlets, end walls, or manholes; and cleaning the existing pipes as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Selected Backfill. Selected backfill shall conform to the Specification Section 31 23 23.13, (Select Backfill).

B. Concrete Mix No. 2. Concrete Mix No. 2 shall conform to the Specification Section 03 30 00, (Portland Cement Concrete Structures).

C. Gravel bedding material for pipe shall meet the requirements of 31 23 33, (Trenching and Backfilling).

D. Submit certificates of compliance before delivery of materials in accordance with 01 33 23, (Shop Drawings, Product Data, and Samples) for pipe and fittings furnished by the Contractor under this Section. A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer. Certificates shall include City Contract Number, job location, Contractor's name, types, classes and strengths of pipe and pipe manufacturer's name.

E. Pipe. Pipe shall conform to the following, unless otherwise specified:

MATERIAL	SPECIFICATION	REMARKS
Nonreinforced Concrete Pipe	M 86, Class 3	—
Reinforced Concrete Pipe	M 170, Class, 4 & 5	54 in. and smaller diameter, load bearing option.
		60 in. and larger diameter, material option.
Concrete End Sections	M 170	—
Reinforced Concrete Arch Culvert	M 206	—
Reinforced Concrete Elliptical Pipe	M 207	Horizontal elliptical pipe only.
Preformed Rubber Joint for Circular Pipe	M 198, Type A	—
Corrugated Steel Pipe, Pipe Arches & Underdrain	M 36 (b), (c)	End finish shall be annular corrugations.
Corrugated Aluminum Alloy Pipe	M 196 (b)	End finish shall be annular corrugations.
Structural Plate for Pipe, Pipe Arches & Arches	M 167	—
Polyethylene (PE) Precoated Corrugated Steel Pipe	M 245 & M 246	Minimum thickness 10 mil on each of the surfaces.
Nonasbestos Fiber Cement Storm Drain Pipe	C 1450	12 in. to 48 in. diameter.
Reinforced Concrete Low Head Pressure Pipe	C 361	Pond spillways.
Polyethylene (PE) Plastic	M252 or M29	Underdrain outlet pipe Type S minimum stiffness 50 psi.

Note (a): Perforations shall conform to the requirements of F 758.
Note (b): Bands with dimples are prohibited.
Note (c): All Corrugated Steel Pipe shall be aluminum coated Type 2 conforming to M 274.

2.2 SOURCE QUALITY CONTROL

A. Certified Reinforced Concrete Pipe Plants. Reinforced concrete pipe conforming to the Specifications will be accepted on the manufacturer's certification based on the requirements outlined below. This includes the sampling, testing, documentation, and certification of the product by the manufacturer in combination with a City monitoring program.

1. Responsibilities of the Concrete Pipe Producer. The concrete pipe producer shall submit a quality control plan to the Engineer for approval prior to the start of production. The plan shall indicate the following:

a. Reinforced concrete pipe shall conform to the applicable portion of the pipe table under 2.1E.
b. The manner in which the materials will be handled.
c. Quality control procedures shall include the following:

1) The names, qualifications, and responsibilities of the quality control personnel and the designation of a quality control manager.

2) Sampling and testing in conformance with Maryland Standard Method of Tests Sample Frequency Guide Table 1.
3) Method used for inspecting reinforcement cages prior to and during production.
4) Method of curing.
5) Method of maintaining accurate quality control records.
6) Samples of forms approved by the City.
7) Patching procedure.
8) Method of preparation of units for shipping.
9) Method of identification of each unit as tested and approved.

d. A lot is defined as a production run of concrete pipe, all being of like size, material, strength designation, and manufactured by the same process. The lot size may include up to 500 units produced in not more than fourteen (14) days. The fourteen (14) days need not be consecutive, as long as they occur within a one (1) month period and the process is not altered in any way between production days.

1) If a manufacturing process is used which produces two or more pipe sizes, styles, or classes simultaneously, one (1) set of material tests (compression and absorption) may be used to represent all sizes, styles or classes, provided there is no change in the mix design. Individual load bearing tests, if used as a basis of acceptance, will be required for each size, style, or class in conformance with the Maryland Standard Method of Tests Frequency Guide.

e. Test Facilities. The producer's facilities, equipment, and testing personnel shall be capable of conducting the tests specified in T#280 and shall be as approved by the Engineer.

1) If compression cylinders or cores are used in lieu of three (3) edge bearing tests, they shall be as specified in T#22.
2) The producer shall maintain yearly calibration certificates on all equipment used for testing.
3) The producer may elect to use the services of an independent commercial testing laboratory that is acceptable to the Engineer, in lieu of conducting their own tests.

f. Shipment. Units may be shipped to the City's projects under either of the following conditions:

1) The required testing for all units in the lot has been completed with acceptable results and all of the units to be shipped are at least the age of the test specimens at testing.
2) Units otherwise conforming to all test criteria may be shipped prior to completion of absorption testing if the concrete mix and manufacturing process used have historically produced the required absorption results, with final acceptance pending acceptable test results.
3) The quality control stamp shall be affixed to each unit shipped.

g. Certification. A manufacturer's certification shall accompany each shipment of pipe. A copy of the certification shall be delivered to the Engineer and the Contractor for each shipment. One (1) copy shall remain at the plant. The certification shall include the following:

1) The plant name, address, and location.
2) Size and class of the pipe.
3) Date of manufacture and shipment.
4) Number of units or linear feet.
5) City Contract Number.
6) Statement of Specification compliance.
7) Signature of the quality control manager.

h. Records. All testing and inspection documents shall be maintained at the production plant for a minimum of three (3) years from the manufactured date and shall be made available to the City upon request.

i. The producer shall collect and maintain conformance certificates and mill test reports for aggregates, cement, joint material, and reinforcing steel intended for use in products used on City projects.

j. Quality Control Forms. The producer shall maintain a City approved quality control form for all pipe produced for use on City projects. Each form, for each lot shall contain the following:

<table>
<tr><th>PIPE DIMENSIONS</th><th>REINFORCEMENT</th><th>TESTS</th><th>GENERAL INFORMATION</th></tr>
<tr><td>Diameter
Length
Wall Thickness
Joint Style</td><td>Size
Spacing
Area Spec &
Test Results
Adequacy &
Quality of Welds & Splices</td><td>Cylinder
Compressive Strength
Spec & Test Results

Core
Compressive Strength
Spec & Test Results

Absorption
Spec & Test Results

Visual Inspection</td><td>Plant Name
Technician Signature
Lot Identification
Production Dates
Pipe Class
Units Per Lot

Material Sources
Cement
Fine Aggregate
Coarse Aggregate
Reinforcement</td></tr>
<tr><th colspan="2">THREE EDGE BEARING</th><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>0.01 in. Crack Strength Spec & Test Results</td><td>Ultimate Strength Spec & Test Results</td></tr>
</table>

2. Responsibilities of the City. Verification of certification will be performed at the discretion of the City a minimum of once per year.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Delivery of pipe shall be coordinated with installation or shall be unloaded with proper equipment along the line of Work, outside trench limits near as practicable to point of final placement, facing in proper direction and properly wedged secure. It shall be stored away from brush, poison oak or ivy and in an accessible area for inspection.

B. Reinforced concrete pipe, specials and appurtenances shall be unloaded and handled with a crane or backhoe of adequate.

C. If damage occurs and is deemed repairable, it shall be repaired as directed by the Engineer in accordance with manufacturer's recommendations. If damage is not repairable in the opinion of the Engineer, such pipe and specials will be rejected and shall be removed and replaced at the Contractor's expense.

3.2 INSTALLATION AND REPAIR RECOMMENDATIONS

A. Submit manufacturer's recommended installation and repair methods and procedures for pipe.

B. Repairs shall be performed by the manufacturer using specifically trained personnel and shall proceed only after approval of the Engineer and in its presence.

C. Above submittal may be waived when the manufacturer has its approved installation and repair methods on file with the Engineer.

3.3 CONCRETE PIPES AND METAL PIPES

A. General:

1. Pipe lengths and gradients shall be verified by the Contractor and shall be acceptable to the Engineer before installation.
2. Pipe End walls, when visible from the roadway, shall be constructed parallel to the roadway and askew pipe shall protrude through the end wall. End walls, not visible from the roadway, shall be constructed normal to the center line of the pipe.
3. The existing pipes shall be cleaned and the material disposed of as directed by the Engineer.

B. Excavation: Refer to Specification section 31 23 33, (Trenching and Backfilling) for pipe trenching Specifications.

C. Bedding:

1. When rock is encountered, it shall be removed and replaced with a minimum eight inches (8″) of selected backfill as directed by the Engineer.
2. When unsuitable foundation material is encountered, it shall be removed and replaced with selected backfill for the full width of the trench as directed by the Engineer.

3. Culverts forty-eight inches (48″) or more in nominal horizontal diameter shall be bedded in an approved foundation shaped by means of a template which will support the pipe for at least ten percent (10%) of its overall height.

D. Installation: Prior to pipe installation bring bedding material to grade along entire length of pipe to be installed. Install pipe to a true uniform line and grade as indicated with continuous bearing of barrel on bedding material. Pipes shall be laid with hubs upgrade. A single lay hole through the shell of the pipe will be permitted with an approved lifting device. The lay hole shall be cast in the pipe during fabrication or cored without damaging any reinforcement. After installation, the lay hole shall be permanently sealed by filling with mortar, rubber plug, or other means approved by the engineer. Wood plugs are prohibited.

E. Joints:

1. Pipe joints shall be sealed in a manner appropriate to the pipe material.
2. Reinforced Concrete Pipe Joints shall be sealed with rubber type gaskets (circular pipe) or resilient type material (elliptical pipe) conforming to M 198. Mortar joints are prohibited.
3. Metal Pipe joints shall be butted and sealed with rubber gaskets and the sections joined with approved coupling bands conforming to 2.1 E.

F. Pipe Connections:

1. Pipe connections may be either prefabricated or constructed in the field.
2. A field pipe connection shall include cutting a hole in one pipe, inserting and trimming the connecting pipe, and placing a concrete collar using Concrete Mix No. 2 at the connection.
3. In the case of corrugated pipes, a welded connection may be substituted for the concrete collar. The weld shall be coated with a zinc rich paint coating in conformance with M 36.
4. Refer to 33 44 00, (Storm Utility Water Drains) for pipe connections to drainage structures.

G. Pipe Encasement: When specified in the Contract Documents or when directed by the Engineer, pipes shall be encased using Concrete Mix No. 2.

H. Backfill: Refer Specifications Section 31 23 33, (Trenching and Backfilling) for pipe backfilling Specifications.

I. Removal of Existing Pipe Culverts: When specified in the Contract Documents, existing pipe culverts shall be removed and become the property of the Contractor. Backfilling of trenches resulting from pipe removal shall conform to 31 23 33, (Trenching and Backfilling).

J. Relaying Existing Pipe: When specified in the Contract Documents, removed culverts shall be salvaged and relaid in conformance with these Specifications relating to new pipe.

K. Abandoned Pipes: When specified in the Contract Documents or when directed by the Engineer, abandoned pipes shall be plugged using Concrete Mix No. 2 or brick masonry.

3.4 STRUCTURAL PLATE PIPE AND ARCH CULVERT

A. Fabrication:

1. The plates, including required holes, shall be shop fabricated to the required dimensions. The plates shall be shipped complete with proper markings and include all necessary connection devices such as bolts, nuts and washers.
2. The Contractor shall provide Working Drawings, including erection diagrams and strutting tables acceptable to the Engineer. Erection diagrams shall include proposed lengths and lifting locations of preassembled sections. Fabrication shall not be performed until Working Drawings are approved by the Engineer.
3. The plate configurations shall have radii and curvature conforming to AASHTO Standard Specifications for Highway Bridges. When bottom plates are specified to be thicker than top and side plates, the thicker plates for circular pipes shall cover at least twenty-five percent (25%) of the periphery of the circle. For pipe arches, the thicker plates shall include corner plates as well as bottom plates. These culverts shall be laid on a firm bed true to line and grade as specified in the Contract Documents.
4. Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows two inches (2″) apart, with one (1) row in the valley and one (1) in the crest of the corrugations, unless otherwise specified in the Contract Documents. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than twelve inches (12″). The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than one-eighth inch (1/8″).
5. Edges shall be shop cut to line and grade and shall be free from oxide and burrs. Connections shall be staggered so that no more than (3) plates come together at any one point. Plates shall be formed to provide lap joints.

B. Excavation:

1. When a structural plate pipe or structural plate pipe arch is to be laid on existing ground, on or under fill, an embankment shall be constructed to a height of at least eighteen inches (18″), but not more than three feet (3′) above the proposed top of the pipe. The trench shall then be excavated to receive the pipe. The width of the trench shall be sufficient to permit thorough tamping of the backfill under the haunches and around the pipe. This width shall be twice the outside diameter of the pipe or the outside diameter plus eighteen inches (18″) on each side, whichever is less.
2. All suitable material removed from the excavation shall be placed in backfill or stored for future use. Excavated material shall not be wasted without permission of the Engineer. Boulders, logs or other unforeseen unsuitable material encountered shall be removed from excavated material prior to placing as backfill. Unsuitable material shall be disposed of in an approved disposal area.

C. Foundation Preparation:

1. Structural plate pipe or structural plate pipe arch: Structural plate pipe or structural plate pipe arch bedding shall conform to 3.3.C.

2. Rails shall be set and the foundation screeded to be coincidental with the exact shape of the bottom plates, and the screeding shall be done immediately prior to erection.

D. Erection:

1. When strutting is required for structural plate pipe or structural plate pipe arch, it shall be uniform from end to end.
2. Struts shall be left in place until backfills are completed. Nuts and bolts shall be tightened between one hundred and two hundred (100 and 200) ft·lb of torque.
3. When washers are specified for structural plate pipe or structural plate pipe arch, they shall be placed under the turned element. Bolts shall first be distributed over the section being assembled and holes made to align by shifting the plates. For bottom plates, the nuts shall be inside the structure. Nuts shall not be drawn tight until the section is assembled. Before backfilling, all nuts shall be finally tightened and tested to ensure compliance with torque requirements.

E. Backfill:

1. Earth for backfill for structural plate pipe or structural plate pipe arch shall be free from large lumps, clods, and rocks and shall be placed along the side of the culvert for the full width of the trench in layers not exceeding six inches (6″) uncompacted depth.
2. Compaction shall conform to Section 31 23 23, (Tamped Fill). Each layer shall be compacted on both sides of the pipe by means of an approved mechanical tamper. Special care shall be taken to compact the fill thoroughly under the haunches of the pipe.
3. The backfill shall be elevated uniformly along each side of the structural plate pipe or structural plate pipe arch to a height of not less than eighteen inches (18″) above the top of the structure. For structures without headwalls, backfill shall start in the center of the structure. If the structure includes headwalls or spandrel walls, backfilling operations shall start at one wall and extend toward the opposite side. When batteries or multi-cell installations are specified, backfill between cells shall be elevated equally on each side of each cell.
4. No trucks or construction equipment shall be allowed to pass over any part of a structural plate pipe structure until the backfill has been completed and tamped up to a height of not less than eighteen inches (18″) above the structure.

F. Concrete Invert:

1. When specified in the Contract Documents, the invert of structural plate pipe or structural plate pipe arch culverts shall be paved using Concrete Mix No. 2.
2. The concrete shall be placed and cured as specified in 03 30 00, (Portland Cement Concrete Structures).

G. End Treatments:

1. Ends of structural plate pipes and structural plate pipe arches shall be shop fabricated on a bevel to fit and be flush with the slope and alignment of the surface through which they protrude, except that where an end wall or masonry slope

protection is specified, the ends of the structural plates shall then be shop fabricated to fit that construction.

2. The ends of all structural plate pipes and structural plate pipe arches that require an end treatment (end wall or slope protection) shall contain hook bolts for anchorage into the concrete.

H. Headwalls: For structural plate pipes and pipe arches shall conform to 33 49 00, (Storm Drainage Structures) and unless otherwise specified, shall be constructed parallel to the proposed outer edge of the roadway shoulder.

PART 4 MEASUREMENT AND PAYMENT

A. The payment for the items specified in the Contract Documents will be full compensation for all applicable excavation, sheeting, shoring, dewatering, hauling, invert paving, storing, rehandling of material, removal and disposal of excess and unsuitable material, tamped fill, forming bed or foundation, backfill, compaction and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. New pipe culverts will be measured complete in place and paid for at the Contract Unit Price per linear foot. When a new pipe is to be installed at the same location as an existing pipe, the cost of removal and disposal of the existing pipe, including end walls and end sections, will not be measured but the cost will be incidental to the Contract Price of new pipe.

C. Pipe Connections and Elbows will be measured and paid for at the Contract Unit Price per each. No deduction from the pipe measurement will be made for pipe connections. Connections to drainage structures containing prefabricated holes in which the pipe will be connected with grout or mortar will not be measured, but the cost will be incidental to the pertinent Pipe item.

D. Excavation required below the planned elevation will be measured and paid for as specified in 31 23 33, (Trenching and Backfilling).

E. Removal of Existing Pipe will be measured and paid for per the total number of linear feet removed, regardless of the condition. When a multiple pipe installation is removed, each pipe will be measured and paid for. End walls, end sections, etc. removed with the pipe will not be measured but the cost will be incidental to the Contract Price.

F. Selected backfill will be measured and paid for as specified in 31 23 33, (Trenching and Backfilling).

G. Relaid Existing Pipe Culverts: Any Size will be measured and paid for as specified in 4 B unless otherwise specified in the Contract Documents.

H. New end walls, end sections, etc., will be measured and paid for as specified in 33 44 00, (Storm Utility Water Drains).

I. Removal of existing headwalls, end sections, etc., that are not incidental to the Contract Price for the respective pipe items will be measured and paid for as specified in 02 41 13.14 (Minor Site Demolition).

J. Encasement concrete and concrete or brick masonry to plug existing pipes will be measured and paid for at the Contract Price for the pertinent Concrete Mix No. 2 for Miscellaneous Structures or Brick Masonry for Miscellaneous Structures item.

K. Clean Existing Pipe Any Size will be measured and paid for at the Contract Unit Price per linear foot.

L. Structural Plate Pipe and Structural Plate Pipe Arch Culverts will be measured and paid for at the Contract Unit Price per linear foot. Measurement will be as follows: measure the top length and the bottom length and average. The average length will be the pay length for each pipe in the structure. For multiple pipes, the length will be totaled to obtain the total pay length.

33 44 00 STORM UTILITY WATER DRAINS

33 44 13.23 PREFABRICATED EDGE DRAINS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing a prefabricated edge drain system and underdrain pipe outlets as specified In the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Outlet Pipe shall conform to 33 41 00, (Storm Water Drains and Sanitary Sewers).

B. Select Borrow. Refer to 31 23 16.12, (Borrow Excavation).

C. Prefabricated Edge Drain and Fittings shall conform to the following:

1. Certification: The manufacturer shall furnish a certification. A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

    a. Certifications for metal products, when required, shall include a statement that the material was melted and manufactured in the United States except as provided in the federal laws with regard to the furnishing and coating of iron and steel products. A nationwide waiver for this provision has been granted for pig iron and processed, pelletized, and reduced iron ore.

2. Prefabricated Edge Drain: Prefabricated edge drains shall be flexible, rectangular conduit consisting of supporting drainage core encased in a geotextile.

    a. Drainage core material shall be manufactured from polymers having a high resistance to deterioration by pavement deicing salts, petroleum based

materials, and naturally occurring soil chemicals. The core shall have sufficient flexibility to withstand bending and handling without damage or significant weakening.

b. The core geotextile contact point spacing for post and cuspated sheet type cores shall not exceed one and one-eighth inches (1.125″). Elongated pipe core sections shall have a seven and one-half (7.5″) inches/ft minimum open area to allow lateral flow into the core. Cores with support on only one side shall have a minimum of five percent (5%) of the area of that support side in unobstructed flow. The drain core shall conform to the following requirements:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Thickness, inches min	—	0.75
Compressive Strength, psi, @ 20% maximum deformation, min	(a)	40
In plane Flow Rate, gal/min/ft of width, min	D 4716 (b)	15

1) D 5034 for crushed sheet and post type cores. D 2412 for elongated pipe type cores.
2) Ten (10) psi load after one hundred (100) hr at a hydraulic gradient of 0.1.

c. The geotextile wrap for prefabricated edge drain shall conform to 33 46 16.19, (Pipe Underdrains) Class SD, Type II.

d. The fabric shall be bonded to contact points of supporting core for post and cuspated sheet type cores to ensure that the geotextile does not sag into the core flow area. The geotextile shall be tightly stretched over the core for elongated pipe type cores.

3. Fittings for the pavement edge drain systems, including, but not limited to end seals, splices, outlets, and shunts shall conform to the manufacturer's recommendations and shall be of sufficient strength to withstand construction handling and permanent loading. All fittings shall be as approved by the Engineer.

D. Pipe for outlets shall be six inches (6″) minimum diameter and shall conform to 33 41 00, (Storm Water Drains and Sanitary Sewers).

PART 3 EXECUTION

3.1 GENERAL

Prefabricated edge drains shall be installed in conformance with the manufacturer's recommendations. Drains with support on only one side shall have the support side placed away from the pavement edge. Refer to 31 23 16.16, (Structure Excavation) for excavated material.

3.2 TRENCHES FOR PREFABRICATED EDGE DRAINS

Trenches shall be excavated with a trencher and shall be as narrow as possible yet wide enough to allow insertion of the prefabricated edge drains at the required elevation. The maximum width of the trench shall be ten inches (10″). The exposed edge of the

pavement shall be free of soil to ensure direct contact between the drain and pavement. The excavation of the trench, placement of the edge drain, and placement of the first lift of backfill shall be accomplished in a single continuous operation, unless otherwise directed by the Engineer.

3.3 SPLICES

A. Splices shall be made prior to placement of the prefabricated edge drain in the trench and in conformance with the manufacturer's recommendations. All splices shall be as approved by the Engineer.

B. Solid, Central Cores (unconnected two sided flow). Crossover couplings shall be used at all splices and at two hundred foot (200') intervals.

3.4 CONNECTIONS TO OUTLETS

A. The prefabricated edge drain shall be connected to the outlets using fittings recommended by the manufacturer.

B. Outlets shall be spaced at two hundred foot (200') intervals and at the lowest elevation on all vertical curves. Outlets shall be constructed in conformance with 33 46 16.19, (Pipe Underdrains).

3.5 BACKFILLING OF TRENCHES

A. Unless otherwise specified in the Contract Documents, material for backfilling trenches shall be the material generated from the trenching operation, as approved by the Engineer. Additional backfill material, if needed, shall conform to Select Borrow.

B. Backfilling shall be completed in two (2) layers with the first layer being placed simultaneously with the drain, holding the drain flush against the side of the pavement. Backfill material shall be compacted using a vibratory shoe compactor.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for excavation, backfill, compaction, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Prefabricated Edge Drains and Outlet Pipe will be measured and paid for at the Contract Unit Price per linear foot.

C. Additional backfill material authorized by the Engineer will be measured and paid for at the Contract Unit Price per cubic yard for Select Borrow Excavation.

33 44 19.12 BIORETENTION FACILITIES

PART 1 GENERAL

1.1 DESCRIPTION

Bioretention Facilities are small landscaped basins intended to provide water quality management by filtering storm water runoff before release into storm drain systems and waterways. This Work shall consist of installing Bioretention Facilities as specified in the Contract Documents or as directed by the Engineer, including all materials, equipment, labor and incidentals required to perform the Work.

PART 2 PRODUCT

2.1 MATERIALS

A. ASTM C33 Fine Aggregate (Sand) shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. No. 57 Stone Aggregate shall conform to M-43, No. 57.

C. No. 7 Stone Aggregate shall conform to M-43, No. 7.

D. No. 2 Stone Aggregate shall conform to M-43, No. 2.

E. Mulch, 2x Shredded Hardwood Bark shall conform to 31 25 00.01, Part 2, (Erosion and Sediment Control).

F. Plant Materials shall conform to 32 90 00.01, Part 2, (Planting Trees, Shrubs, Vines, and Seeding Stock).

G. Water shall conform to 32 92 23.01, Part 2, (Turf Establishment).

H. Limestone shall conform to 32 92 23.01, Part 2, (Turf Establishment).

I. Iron Sulfate shall conform to 32 92 23, Part 2, (Sodding).

J. Geotextile, Class PE, Type III shall conform to 33 46 16.19, Part 2, (Pipe Underdrains).

K. Pipe, six inch (6″) Polyvinyl Chloride Profile Wall Pipe (PPWP) and Fittings. Pipe used includes perforated and nonperforated. Pipe and fittings shall conform to M-304.

Magnesium Sulfate (Epsom Salt). The material shall be colorless, solid at ambient temperatures, formed in small needle-like rhombic crystals, free of solid or fibrous foreign matter, shall be of agricultural grade and will conform to the following: $MgSO_4$, Anhydrous, % (min)Wt.	99.0
Heavy Metals (as Lead or Pb), ppm (max)	10
Arsenic ppm (max)	3.0
Selenium, % (max)	0.0030
Boron, ppm (max)	15
Chlorides (as Cl), % (max)	00.06
Sodium Salts (as Na), ppm (max)	25
Potassium Salts (as K), ppm (max)	25
Calcium Salts (as Ca), ppm (max)	25

L. Potash. The material shall be white in color, solid at ambient temperatures, crystallized, free of solid or fibrous foreign matter shall be of agricultural grade and shall have a minimum percent weight of 60 for K_2O.

M. Planting Soil.

1. The planting soil shall be a friable soil uniform in color and texture and not supplied from the project but must be furnished. The planting soil shall be free from any parts of Johnson grass, Canadian Thistle, or Phragmites. The USDA textural classification of the planting soil shall be loamy sand or sandy loam. The planting soil shall meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Sand (2.0–0.050 mm)	50–85%	T88
Silt (0.050–0.002 mm)	0–50%	T88
Clay (less than 0.002 mm)	5–10%	T88
Organic Matter	1.5–10%	T194

The textural analysis for the planting soil shall be as follows:

SIEVE SIZE	MINIMUM PERCENT
2 inch	100
No. 4	90
No. 10	80

2. At least forty-five (45) days prior to the start of construction of Bioretention Facilities, the Contractor shall submit the source of the planting soil to the Engineer for approval. No time extensions will be granted should the proposed planting soil fail to meet the minimum requirements stated above. Once a stockpile of the planting soil has been sampled, no material shall be added to the stockpile.
3. Planting soil that fails to meet the minimum requirements shall be replaced at no additional cost to the City.

N. Bioretention. Soil Mixture (BSM). The Bioretention Soil Mixture (BSM) is a mixture of planting soil, mulch and sand consisting of the following:

ITEM	COMPOSITION BY VOLUME	REFERENCE
Planting Soil	30%	See above.
Shredded 2x Hardwood Mulch	20%	920.05.01
Sand	50%	ASTM C33 Fine Aggregate

1. The BSM shall be a homogeneous mix, free of stones, stumps, roots or other similar objects larger than two inches (2″) excluding mulch. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plant growth or prove a hindrance to the planting or maintenance operations. The BSM shall be free of Bermuda grass, Quackgrass, Johnson grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, Teathumb, Phragmites or other noxious weeds as specified in COMAR 15.08.01.05.

   The BSM shall meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Corrected pH	5.5–7.5	D4972
Magnesium	Minimum 35 ppm	*
Phosphorus (Phosphate—P_2O_5)	Minimum 75 ppm	*
Potassium (K_2O)	Minimum 85 ppm	*
Soluble Salts	Not to exceed 500 ppm	*

* University of Maryland, Cooperative Extension Service, Department of Agronomy Test Method.

2. Should the pH fall outside of the acceptable range, it may be modified with limestone (to raise) or iron sulfate (to lower). The limestone or iron sulfate must be mixed uniformly into the BSM prior to use in bioretention facilities.
3. Should the BSM not meet the minimum requirement for magnesium, it may be modified with magnesium sulfate (Epsom salt). Likewise, should the BSM not meet the minimum requirement for potassium, it may be modified with potash. Magnesium sulfate (Epsom salt) and potash must be mixed uniformly into the BSM prior to use in Bioretention Facilities.
4. BSM that fails to meet the minimum requirements shall be replaced at no additional cost to the City. Mixing of the corrective additives to the BSM is incidental and shall be at no additional cost to the City.
5. Mixing of the BSM to a homogeneous consistency shall be done to the satisfaction of the Engineer. Rototilling any type of amendment to the BSM is insufficient and destroys the unique matrix of the soil and is not be an acceptable mixing procedure.

PART 3 EXECUTION

3.1 GENERAL

A. Bioretention Facilities shall not be constructed until all contributing drainage areas are stabilized as shown on the Contract Plans and to the satisfaction of the Engineer. Bioretention Facilities shall not be used as sediment control facilities. No heavy

equipment shall operate within the perimeter of a Bioretention Facility during excavation, pipe system placement, backfilling, planting or mulching of the facility.

B. Excavation. The Bioretention Facility shall be excavated to the dimensions, side slopes and elevations shown on the Contract Plans. The method of excavation shall minimize the compaction of the bottom of the Bioretention Facility. Excavators and backhoes, operating on the ground adjacent to the Bioretention Facility shall be used to excavate the facility. No heavy equipment shall be allowed on the bottom of the Bioretention Facility. However, if the configuration of the facility requires that equipment operate on the bottom of the facility during excavation, wide track or marsh track equipment or light equipment with turf tires, shall be used. The use of equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high pressure tires is prohibited.

C. Excavated materials shall be removed from the Bioretention Facility site. Excavated materials shall be used or disposed of in conformance with 31 23 16.10, (Roadway Excavation).

D. Prior to placing the pipe and the BSM, the bottom of the excavation shall be rototilled to a minimum depth of six inches (6″) to alleviate any compaction of the facility bottom. Any substitute method for rototilling must be approved by the Engineer prior to use. Any ponded water shall be removed from the bottom of the facility and the soil shall be friable before rototilling.

3.2 GEOTEXTILE

A. Following rototilling of the facility bottom, geotextile shall be placed on all sides of the facility as shown on the Contract Plans. Geotextile shall not be placed on the bottom of the facility. Geotextile shall be placed tightly against the facility walls to eliminate voids beneath.

B. Geotextile; wrinkles and folds in the geotextile shall be avoided. A minimum six inches (6″) overlap at the geotextile joint ends or breaks shall be maintained. Geotextile joints and overlaps shall be pinned to securely hold the geotextile in place until placement of the BSM.

C. Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the City.

3.2 PERFORATED PIPE SYSTEM

A. The perforated pipe system using six inch (6″) Polyvinyl Chloride Profile Wall Pipe (PPWP) shall be placed on a three foot (3′) wide (minimum) bed of No. 2 aggregate. The minimum thickness of the No. 2 aggregate shall be six inches (6″). Pipe shall be covered with six inches (6″) of No. 57 aggregate and topped with an additional four inch (4″) minimum layer of No. 7 aggregate. All aggregate shall be placed according to dimensions shown on the Contract Plans. Aggregate shall be covered with a four inch (4″) minimum sand layer. Pipe outlets shall be outletted into drainage structures.

B. The ends of pipes not terminating in a cleanout, vent or drainage structure shall be capped.

C. All aggregate shall be clean and free of all soil and fines. Care shall be taken to prevent soil and fines from intermixing with the aggregate. All contaminated aggregate shall be removed and replaced with uncontaminated aggregate at no additional cost to the City.

3.3 CLEANOUTS

Cleanouts of six inch (6″) nonperforated PPWP shall be placed vertically in the bioretention facility as shown on the Contract Plans. The cleanouts shall be connected to the perforated pipe system with the appropriate manufactured connections as shown on the Contract Plans. The cleanouts shall extend six inches (6″) above the top elevation of the bioretention facility mulch and shall be capped with a screw cap.

3.4 OBSERVATION WELLS

Observation wells of six inch (6″) perforated PPWP (color: white) shall be placed vertically in the bioretention facility as shown on the Contract Plans. The wells shall extend six inches (6″) above the top elevation of the bioretention facility mulch and shall be capped with a screw cap. The well shall be supplied with an appropriate geotextile sock as recommended by the manufacturer.

3.5 VENTS

A. Inverted J-vents using six inch (6″) nonperforated PPWP shall be placed vertically in the bioretention facility as shown on the Contract Plans. The vents shall be connected to the perforated pipe system with the appropriate manufactured connections as shown on the Contract Plans. The inverted J-vents shall extend above the water surface elevation of the bioretention facility.

B. Placement and Compaction of the Bioretention Soil Mixture (BSM). The Bioretention Soil Mixture (BSM) shall be placed and graded by using excavation hoes operating on the ground adjacent to the Bioretention Facility. No heavy equipment shall be used within the perimeter of the Bioretention Facility before, during or after the placement of the BSM. However, if the configuration of the facility is exceedingly large, wide track or marsh track equipment or light equipment with turf type tires operating within the perimeter of the facility may be used to place and grade the BSM.

C. The BSM shall be placed in horizontal layers not to exceed 12 inches (12″) for the entire area of the Bioretention Facility. The BSM shall be compacted by saturating the entire area of the Bioretention Facility after each lift of BSM is placed until water flows from the perforated pipe system. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence of the Engineer. An appropriate sediment control device shall be used to treat any sediment laden water discharged from the perforated pipe system. If the BSM becomes contaminated during the construction of the facility, the contaminated material shall be removed and replaced with uncontaminated material at no additional cost to the City. Final grading of the BSM shall be performed after a twenty-four (24) hour settling period. Final elevations shall be within two inches (2″) of elevations shown on the Contract Plans.

D. Plant Installation. Refer to 32 90 00.01, (Planting Trees, Shrubs, Vines and Seedling Stock) in Bioretention Facilities and 32 93 23, (Planting Annuals, Perennials, Fall Planted Bulbs and Ornamental Grasses) in Bioretention Facilities.

3.6 MULCHING

Once the plants are in place, the entire Bioretention Facility shall be mulched to a uniform thickness of three inches (3″). Well aged (minimum age of six (6) months) shredded

hardwood bark mulch is the only acceptable mulch. If plants cannot be installed into the facility within forty-eight (48) hours of final facility grading, the entire facility shall be temporarily stabilized with mulch at a uniform thickness of one inch (1″).

PART 4 MEASUREMENT AND PAYMENT

A. Bioretention facilities will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for all applicable excavation, sheeting, shoring, dewatering, rototilling, loading, hauling, storing, rehandling of material, removal and disposal of excess and unsuitable material, PVC pipe, aggregate, geotextile, furnishing, mixing, pH correction, potassium correction, magnesium correction, and placement of the BSM backfill, compaction of the BSM backfill by saturation, grading and slope adjustments, water for BSM saturation, mulch, sand, planting soil, and for all material, labor, equipment, tools, and incidentals necessary satisfactorily complete the Work.

B. Discharge from Perforated Pipe System. Any sediment laden water discharged from the perforated pipe system shall be filtered or removed from the outlet structure and is incidental to complete the Work.

C. Plantings. Plant materials placed in Bioretention Facilities shall be measured and paid for at the Contract Unit Price per each item specified in the Contract Documents.

33 44 19 UTILITY STORM WATER TREATMENT

33 44 19.14 DRY SWALE FACILITIES

PART 1 GENERAL

1.1 DESCRIPTION

Dry Swale Facilities are linear, trapezoidal vegetated swales intended to provide water quality management by filtering storm water runoff before release into storm drain systems and waterways. This Work shall consist of installing Dry Swale Facilities as specified in the Contract Documents or as directed by the Engineer, including all materials, equipment, labor and incidentals required to perform the Work.

PART 2 PRODUCT

2.1 MATERIALS

A. ASTM C33 Fine Aggregate (Sand) shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. No. 57 Stone Aggregate shall conform to M-43, No. 57.

C. No. 7 Stone Aggregate shall conform to M-43, No. 7.

D. No. 2 Stone Aggregate shall conform to M-43, No. 2.

E. Mulch: 2x Shredded Hardwood Bark shall conform to 31 25 00.01, Part 2, (Erosion and Sediment Control).

F. Plant Materials shall conform to 32 90 00.01, Part 2, (Planting Trees, Shrubs, Vines, and Seeding Stock).

G. Water shall conform to 32 92 23.01, Part 2, (Turf Establishment).

H. Limestone shall conform to 32 92 23.01, Part 2, (Turf Establishment).

I. Iron Sulfate shall conform to 32 92 23, Part 2, (Sodding).

J. Geotextile, Class PE, Type III shall conform to 33 46 16.19, Part 2, (Pipe Underdrains).

K. Sod shall conform to 32 92 23, Part 2, (Sodding).

L. Pipe: Six inch (6″) Polyvinyl Chloride Profile Wall Pipe (PPWP) and Fittings. Pipe used includes perforated and nonperforated. Pipe and fittings shall conform to M-304.

M. Magnesium Sulfate (Epsom Salt). The material shall be colorless, solid at ambient temperatures, formed in small needle-like rhombic crystals, free of solid or fibrous foreign matter, shall be of agricultural grade and will conform to the following:

$MgSO_4$, Anhydrous, % (min) Wt.	99.0
Heavy Metals (as Lead or Pb), ppm (max)	10
Arsenic ppm (max)	3.0
Selenium, % (max)	0.0030
Boron, ppm (max)	15
Chlorides (as Cl), % (max)	00.06
Sodium Salts (as Na), ppm (max)	25
Potassium Salts (as K), ppm (max)	25
Calcium Salts (as Ca), ppm (max)	25

N. Potash. The material shall be white in color, solid at ambient temperatures, crystallized, free of solid or fibrous foreign matter shall be of agricultural grade and shall have a minimum percent weight of sixty (60) for K_2O.

O. Planting Soil. The planting soil shall be a friable soil uniform in color and texture and not supplied from the project but must be furnished. The planting soil shall be free from any parts of Bermuda grass, Quackgrass, Johnson grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, Tearthumb, Phragmites or other noxious weeds as specified in COMAR 15.08.01.05. The USDA textural classification of the planting soil shall be loamy sand or sandy loam. The planting soil shall meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Sand (2.0–0.050 mm)	50–85%	T88
Silt (0.050–0.002 mm)	0–50%	T88
Clay (less than 0.002 mm)	5–10%	T88
Organic Matter	1.5–10%	T194

1. The textural analysis for the planting soil shall be as follows:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2 inch	100
No. 4	90
No. 10	80

2. At least forty-five (45) days prior to the start of construction of Dry Swale Facilities, the Contractor shall submit the source of the planting soil to the Engineer for approval. No time extensions will be granted should the proposed planting soil fail to meet the minimum requirements stated above. Once a stockpile of the planting soil has been sampled, no material shall be added to the stockpile.
3. Planting soil that fails to meet the minimum requirements shall be replaced at no additional cost to the City.

P. Bioretention Soil Mixture (BSM). The Bioretention Soil Mixture (BSM) is a mixture of planting soil, mulch and sand consisting of the following:

ITEM	COMPOSITION BY VOLUME	REFERENCE
Planting Soil	30%	See above.
Shredded 2x Hardwood Mulch	20%	920.05.01
Sand	50%	ASTM C33 Fine Aggregate

1. The BSM shall be a homogeneous mix, free of stones, stumps, roots or other similar objects larger than two inches (2″) excluding mulch.
2. The BSM shall meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Corrected pH	5.5–7.5	D4972
Magnesium	Minimum 35 ppm	*
Phosphorus (Phosphate—P_2O_5)	Minimum 75 ppm	*
Potassium (K_2O)	Minimum 85 ppm	*
Soluble Salts	Not to exceed 500 ppm	*

* University of Maryland, Cooperative Extension Service, Department of Agronomy Test Method.

3. Should the pH fall outside of the acceptable range, it may be modified with limestone (to raise) or iron sulfate (to lower). The limestone or iron sulfate must be mixed uniformly into the BSM prior to use in Dry Swale Facilities.
4. Should the BSM not meet the minimum requirement for magnesium, it may be modified with magnesium sulfate (Epsom salt). Likewise, should the BSM not meet the minimum requirement for potassium, it may be modified with potash. Magnesium sulfate (Epsom salt) and potash must be mixed uniformly into the BSM prior to use in Dry Swale Facilities.
5. BSM that fails to meet the minimum requirements shall be replaced at no additional cost to the City.

6. Mixing of the BSM to a homogeneous consistency shall be done to the satisfaction of the Engineer. Rototilling any type of amendment into the BSM is insufficient and destroys the unique matrix of the soil and is not an acceptable mixing procedure.

PART 3 EXECUTION

3.1 GENERAL

Dry Swale Facilities shall not be constructed until all contributing drainage areas are stabilized as shown in the Contract Documents and to the satisfaction of the Engineer. Dry Swale Facilities shall not be used as sediment control facilities.

3.2 EXCAVATION

A. The Dry Swale Facilities shall be excavated to the dimensions, side slopes and elevations shown in the Contract Documents. The method of excavation shall minimize the compaction of the bottom of the Dry Swale Facilities. Excavators, backhoes and other equipment operating within the Dry Swale Facilities shall be wide track or marsh track equipment. The use of light equipment with turf tires is acceptable. The use of equipment with narrow tracks or narrow tires, rubber tires with large lugs or high pressure tires is prohibited.

B. Excavated materials shall be removed from the Dry Swale Facilities sites. Excavated materials shall be used or disposed of in conformance with 31 23 16.10, (Roadway Excavation).

C. Prior to placing the pipe and the BSM, the bottom of the excavation shall be rototilled to a minimum depth of six inches (6″) to alleviate any compaction of the trench bottom. Any substitute method for rototilling must be approved by the Engineer prior to use. Any ponded water shall be removed from the bottom of the trench and the soil shall be friable before rototilling.

3.3 GEOTEXTILE

A. Following rototilling of the trench bottom, geotextile shall be placed on all sides of Dry Swale Facilities as shown in the Contract Documents. Geotextile shall not be placed on the trench bottom. Geotextile shall be placed tightly against the Dry Swale walls to eliminate voids beneath the geotextile. Wrinkles and folds in the geotextile shall be avoided. A minimum six inches (6″) overlap at the geotextile joint ends or breaks shall be maintained. Geotextile joints and overlaps shall be pinned to securely hold the geotextile in place until placement of the BSM.

B. Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the City.

3.4 PERFORATED PIPE SYSTEM

A. A perforated pipe system using six inch (6″) Polyvinyl Chloride Profile Wall Pipe (PPWP) shall be placed on a bed of No. 2 aggregate (minimum bed thickness of six inches (6″)) that covers the entire trench bottom. Pipe shall be covered with six inches (6″) of No. 57 aggregate and topped with an additional four inch (4″) minimum layer of No. 7 aggregate. All aggregate shall be placed according to dimensions shown in the Contract Documents.

Aggregate shall be covered with a four inch (4″) minimum sand layer. Pipe outlets shall be connected to drainage structures.

B. The ends of pipes not terminating in a cleanout, vent or drainage structure shall be capped.

C. All aggregate shall be clean and free of all soil and fines. Care shall be taken to prevent soil and fines from intermixing with the aggregate. All contaminated aggregate shall be removed and replaced with uncontaminated aggregate as directed by the Engineer at no additional cost to the City.

3.4 CLEANOUTS

Cleanouts of six inch (6″) nonperforated PPWP shall be placed vertically in Dry Swale Facilities as shown in the Contract Documents. The cleanouts shall be connected to the perforated pipe system with the appropriate manufactured connections as shown in the Contract Documents. The cleanouts shall extend six inches (6″) above the top elevation of Dry Swale Facilities and shall be capped with a screw cap.

3.5 OBSERVATION WELLS

Observation wells of six inch (6″) perforated PPWP (color: white) shall be placed vertically in Dry Swale Facilities as shown in the Contract Documents. The observation wells shall extend six inches (6″) above the top elevation of Dry Swale Facilities and shall be capped with a screw cap. The top ten inches (10”) of the observation well pipe shall be nonperforated and shall connect to the perforated observation well pipe with an appropriate manufactured connection. The observation well shall be wrapped with an appropriate geotextile sock as recommended and provided by the manufacturer.

3.6 VENTS

Inverted J-vents using six inch (6″) nonperforated PPWP shall be placed vertically in Dry Swale Facilities as shown in the Contract Documents. The vents shall be connected to the perforated pipe system with the appropriate manufactured connections as shown in the Contract Documents. The inverted J-vents shall extend above the design water surface elevation of the Dry Swale Facilities.

3.7 PLACEMENT AND COMPACTION OF THE BSM

A. The BSM shall be placed and graded by using wide track or marsh track equipment or light equipment with turf type tires operating within the perimeter of the Dry Swale Facilities.

B. The BSM shall be placed in horizontal layers not to exceed twelve inches (12″) for the entire area of the trench. The BSM shall be compacted by saturating the trench after each lift of BSM is placed until water flows from the perforated pipe system. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence and to the satisfaction of the Engineer. An appropriate sediment control device shall be used to treat any sediment laden water discharged from the perforated pipe system. If the BSM becomes contaminated during the construction of Dry Swale Facilities, the contaminated material shall be removed and replaced with uncontaminated material at no additional cost to the City. Final grading of the BSM shall be performed after a twenty-four (24) hour settling period. Final elevations shall be within two inches (2″) of elevations shown in the Contract Documents.

3.8 PLACEMENT OF SOD

Immediately following the twenty-four (24) hour settling period for final grading of the Dry Swale Facilities, the entire length and width of the Dry Swale Facilities shall be sodded. Sod shall be placed in accordance with 32 92 23, (Sodding) with the following exception; liming shall not apply.

PART 4 MEASUREMENT AND PAYMENT

A. The payment for the items specified in the Contract Documents will be full compensation for all applicable excavation, sheeting, shoring, dewatering, rototilling, loading, hauling, storing, rehandling of material, removal and disposal of excess and unsuitable material, PPWP, aggregate, geotextile, furnishing, mixing and placement of the BSM backfill, compaction of the BSM backfill by saturation, grading and slope adjustments, water for BSM saturation, mulch, sand, planting soil, sodding, and for all material, labor, equipment, tools, and incidentals necessary satisfactorily complete the Work.

B. Excavation. Excavation for Dry Swale Facilities will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent Class of Excavation.

C. Dewatering and rototilling of the excavated areas for Dry Swale Facilities will not be measured but will be incidental to excavation.

D. Geotextile. Geotextile for Dry Swale Facilities will be measured and paid for at the Contract Unit Price per square yard for Geotextile Class PE, Type III.

E. Aggregate. Aggregate for Dry Swale Facilities will be measured and paid for at the Contract Unit Price per ton for the pertinent Stone Aggregate item.

F. ASTM C33 Fine Aggregate (Sand). ASTM C33 Fine Aggregate (Sand) for Dry Swale Facilities shall be measured and paid for at the Contract Unit Price per cubic yard for ASTM C33 Fine Aggregate.

G. PPWP. PPWP for Dry Swale Facilities will be measured and paid for at the Contract Unit Price per linear foot for Polyvinyl Chloride Profile Wall Pipe (PPWP). Fittings, manufactured connections and geotextile sleeves will not be measured but will be incidental to the Contract Price.

H. Planting Soil. Planting Soil for Dry Swale Facilities will be measured and paid for at the Contract Unit Price per cubic yard for planting soil for Dry Swale Facilities.

I. BSM. Furnishing, amendments, mixing, mixing of corrective additives, placement, compaction, and grading of BSM will not be measured but will be incidental to the Contract Price of planting soil, fine aggregate, and mulch.

J. Mulch. Mulch will be measured and paid for at the Contract Unit Price per square yard.

K. Watering. Watering for compaction of the BSM in Dry Swale Facilities will be measured and paid for at the Contract Unit Price per 1000 gallons of water applied to the BSM.

L. Sodding. Sod for Dry Swale Facilities will be measured and paid for at the Contract Unit Price per square yard.

M. Discharge from Perforated Pipe System. Any sediment laden water discharged from the perforated pipe system during compaction of the BSM during saturation shall be filtered or removed from the outlet structure and is incidental to completing the Work.

33 44 19.15 DRAINAGE – SURFACE SAND FILTERS

PART 1 GENERAL

1.1 DESCRIPTION

Surface Sand Filters are infiltration systems intended to provide water quality management by filtering storm water runoff before release into storm drain systems and waterways. This Work shall consist of installing Surface Sand Filters as specified in the Contract Documents or as directed by the Engineer, including all materials, equipment, labor and incidentals required to perform the Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. ASTM C33 Fine Aggregate (Sand) shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. No. 57 Stone Aggregate shall conform to M-43, No. 57.

C. No. 7 Stone Aggregate shall conform to M-43, No. 7.

D. No. 2 Stone Aggregate shall conform to M-43, No. 2.

E. Mulch, 2x Shredded Hardwood Bark shall conform to 31 25 00.0, Part 2, (Erosion and Sediment Control).

F. Plant Materials shall conform to 32 90 00.01, Part 2, (Planting Trees, Shrubs, Vines and Seeding Stock).

G. Water shall conform to 32 92 23.01, Part 2, (Turf Establishment).

H. Limestone shall conform to 32 92 23.01, Part 2, (Turf Establishment).

I. Iron Sulfate shall conform to 32 92 23, Part 2, (Sodding).

J. Geotextile, Class PE, Type III shall conform to 33 46 16.19, Part 2, (Pipe Underdrains).

K. Sod shall conform to 32 92 23, Part 2, (Sodding).

L. Pipe, six inch (6″) Polyvinyl Chloride Profile Wall Pipe (PPWP) and Fittings. Pipe used includes perforated and nonperforated. Pipe and fittings shall conform to M-304.

M. Potash. The material shall be white in color, solid at ambient temperatures, crystallized, free of solid or fibrous foreign matter shall be of agricultural grade and shall have a minimum percent weight of sixty (60) for K_2O.

N. Magnesium Sulfate (Epsom Salt). The material shall be colorless, solid at ambient temperatures, formed in small needle-like rhombic crystals, free of solid or fibrous foreign matter shall be of agricultural grade and will conform to the following:

$MgSO_4$, Anhydrous, % (min) Wt.	99.0
Heavy Metals (as Lead or Pb), ppm (max)	10
Arsenic ppm (max)	3.0
Selenium, % (max)	0.0030
Boron, ppm (max)	15
Chlorides (as Cl), % (max)	00.06
Sodium Salts (as Na), ppm (max)	25
Potassium Salts (as K), ppm (max)	25
Calcium Salts (as Ca), ppm (max)	25

O. Planting Soil: The planting soil shall be a friable soil uniform in color and texture and not supplied from the project but must be furnished. The planting soil shall be free from any parts of Bermuda grass, Quackgrass, Johnson grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, Tearthumb, Phragmites or other noxious weeds as specified in COMAR 15.08.01.05. The USDA textural classification of the planting soil shall be loamy sand or sandy loam. The planting soil shall meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Sand (2.0–0.050 mm)	50–85%	T88
Silt (0.050–0.002 mm)	0–50%	T88
Clay (less than 0.002 mm)	5–10%	T88
Organic Matter	1.5–10%	T194

1. The textural analysis for the planting soil shall be as follows:

SIEVE SIZE	MINIMUM PERCENT
2 inch	100
No. 4	90
No. 10	80

2. At least forty-five (45) days prior to the start of construction of Surface Sand Filters, the Contractor shall submit the source of the planting soil to the Engineer for approval. No time extensions will be granted should the proposed planting soil fail to meet the minimum requirements stated above. Once a stockpile of the planting soil has been sampled, no material shall be added to the stockpile.
3. Planting soil that fails to meet the minimum requirements shall be replaced at no additional cost to the City.

P. Bioretention Soil Mixture (BSM). The Bioretention Soil Mixture (BSM) is a mixture of planting soil, mulch and sand consisting of the following:

ITEM	COMPOSITION BY VOLUME	REFERENCE
Planting Soil	30%	See above.
Shredded 2x Hardwood Mulch	20%	920.05.01
Sand	50%	ASTM C33 Fine Aggregate

1. The BSM shall be a homogeneous mix, free of stones, stumps, roots or other similar objects larger than two inches excluding (2″) mulch.
2. The BSM shall meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Corrected pH	5.5–7.5	D4972
Magnesium	Minimum 35 ppm	*
Phosphorus (Phosphate—P_2O_5)	Minimum 75 ppm	*
Potassium (K_2O)	Minimum 85 ppm	*
Soluble Salts	Not to exceed 500 ppm	*

* University of Maryland, Cooperative Extension Service, Department of Agronomy Test Method

3. Should the pH fall outside of the acceptable range, it may be modified with limestone (to raise) or iron sulfate (to lower). The limestone or iron sulfate must be mixed uniformly into the BSM prior to use in Surface Sand Filters.
4. Should the BSM not meet the minimum requirement for magnesium, it may be modified with magnesium sulfate (Epsom salt). Likewise, should the BSM not meet the minimum requirement for potassium, it may be modified with potash. Magnesium sulfate (Epsom salt) and potash must be mixed uniformly into the BSM prior to use in Surface Sand Filters.
5. BSM that fails to meet the minimum requirements shall be replaced at no additional cost to the City. Mixing of the corrective additives to the BSM is incidental and shall be at no additional cost to the City.
6. Mixing of the BSM to a homogeneous consistency shall be done to the satisfaction of the Engineer. Rototilling any type of amendment to the BSM is insufficient and destroys the unique matrix of the soil and is not an acceptable mixing procedure.

PART 3 EXECUTION

3.1 GENERAL

Surface Sand Filters shall not be constructed until all contributing drainage areas are stabilized as shown in the Contract Documents and to the satisfaction of the Engineer. Surface Sand Filters shall not be used as sediment control facilities.

3.2 SURFACE SAND FILTER EXCAVATION

A. Surface Sand Filters shall be excavated to the dimensions, side slopes and elevations shown in the Contract Documents. The method of excavation shall minimize the

compaction of the bottom of the Surface Sand Filters. Excavators and backhoes, operating on the ground adjacent to the Surface Sand Filters shall be used to excavate the facilities when possible. Otherwise, excavators, backhoes and other equipment shall be wide track or marsh track for use within the Surface Sand Filters. The use of light equipment with turf tires operating within the Surface Sand Filters is also acceptable. The use of equipment with narrow tracks or narrow tires, rubber tires with large lugs or high pressure tires is prohibited within Surface Sand Filters.

B. Excavated materials shall be removed from the Surface Sand Filter sites. Excavated materials shall be used or disposed of in conformance with 31 23 16.10, (Roadway Excavation).

C. Prior to placing aggregate, pipe and BSM, the bottom of the excavation shall be rototilled to a minimum depth of six inches (6″) to alleviate any compaction of each Surface Sand Filter bottom. Any substitute method for rototilling must be approved by the Engineer prior to use. Any ponded water shall be removed from the bottom of the Surface Sand Filter sites and the soil shall be friable before rototilling.

3.3 FOREBAY EXCAVATION

The Forebay of the Surface Sand Filters shall be excavated in the same fashion as the Surface Sand Filter. The bottom of the excavation shall be rototilled to a minimum depth of six inches (6”) to alleviate any compaction of the Forebay bottom. Any substitute method for rototilling must be approved by the Engineer prior to use. Any ponded water shall be removed from the bottom of the Surface Sand Filter sites and the soil shall be friable before rototilling.

3.4 FOREBAY AGGREGATE PLACEMENT

The Forebay of the Surface Sand Filter shall be covered by a bed of No. 2 aggregate to the dimensions as shown in the Contract Documents. Aggregate shall be clean and free of all soil and fines. Care shall be taken to prevent soil and fines from intermixing with the aggregate. All contaminated aggregate shall be removed and replaced with uncontaminated aggregate at no additional cost to the City.

3.5 GEOTEXTILE

A. Following rototilling of the Surface Sand Filter bottom, geotextile shall be placed on all sides of the Surface Sand Filters as shown in the Contract Documents. Geotextile shall not be placed on the bottom of the excavated areas. Geotextile shall be placed tightly against each Surface Sand Filter wall to eliminate voids beneath the geotextile. Wrinkles and folds in the geotextile shall be avoided. A minimum six inches (6″) overlap at the geotextile joint ends or breaks shall be maintained. Geotextile joints and overlaps shall be pinned to securely hold the geotextile in place until placement of the BSM.

B. Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the City.

3.6 PERFORATED PIPE SYSTEM

A. The perforated pipe system using six inch (6″) Polyvinyl Chloride Profile Wall Pipe (PPWP) shall be placed on a bed of No. 2 aggregate with a minimum bed thickness of six inches

(6″) that covers the bottom of Surface Sand Filters. Pipe shall be covered with six inches (6″) of No. 57 aggregate and topped with an additional four inch (4″) minimum layer of No. 7 aggregate. All aggregate shall be placed according to dimensions shown in the Contract Documents. Pipe outlets shall be connected to drainage structures.

A. The ends of pipes not terminating in a cleanout, vent or drainage structure shall be capped.

B. All aggregate shall be clean and free of all soil and fines. Care shall be taken to prevent soil and fines from intermixing with the aggregate. All contaminated aggregate shall be removed and replaced with uncontaminated aggregate at no additional cost to the City.

3.7 CLEANOUTS

Cleanouts of six inch (6″) nonperforated PPWP shall be placed vertically in Surface Sand Filters as shown in the Contract Documents. The cleanouts shall be connected to the perforated pipe system with the appropriate manufactured connections as shown in the Contract Documents. The cleanouts shall extend six inches (6″) above the top elevation of the mulch layer and shall be capped with a screw cap.

3.8 OBSERVATION WELLS

Observation wells of six inch (6″) perforated PPWP (color: white) shall be placed vertically in Surface Sand Filters as shown in the Contract Documents. The wells shall terminate at the BSM layer top elevation and shall be capped with a screw cap. The well shall be supplied and installed with an appropriate geotextile sock as recommended by the manufacturer.

3.9 PLACEMENT AND COMPACTION OF SAND

A. The Sand for Surface Sand Filters shall be placed and graded by using excavation hoes operating on the ground adjacent to Surface Sand Filters or if the configuration of the Surface Sand Filters is exceedingly large, wide track or marsh track equipment or light equipment with turf type tires operating within the perimeter of Surface Sand Filters may be used to place and grade the Sand. The use of equipment with narrow tracks or narrow tires, rubber tires with large lugs or high pressure tires is prohibited within the perimeter of Surface Sand Filters.

B. The Sand shall be placed in horizontal layers not to exceed six inches (6″) for the entire area of the Surface Sand Filters as shown in the Contract Documents. The Sand shall be compacted by saturating the entire area of the Surface Sand Filters after each lift of BSM is placed until water flows from the perforated pipe system. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence and to the satisfaction of the Engineer. An appropriate sediment control device shall be used to treat any sediment laden water discharged from the perforated pipe system. If the Sand becomes contaminated during the construction of Surface Sand Filters, the contaminated material shall be removed and replaced with uncontaminated material at no additional cost to the City.

3.10 PLACEMENT AND COMPACTION OF THE BIORETENTION SOIL MIXTURE (BSM)

The Bioretention Soil Mixture (BSM) shall be placed and graded using the same technique for placement and compaction of Sand, however the BSM shall be placed in four inch (4″)

lifts. The BSM shall be compacted by saturating the entire area of the Surface Sand Filters after the BSM is placed until water flows from the perforated pipe system. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence and to the satisfaction of the Engineer. An appropriate sediment control device shall be used to treat any sediment laden water discharged from the perforated pipe system. If the BSM becomes contaminated during the construction of the Surface Sand Filters, the contaminated material shall be removed and replaced with uncontaminated material at no additional cost to the City. Final grading of the BSM shall be performed after a twenty-four (24) hour settling period. Final elevations shall be within two inches (2″) of elevations shown on the Contract Plans.

3.11 PLACEMENT OF SOD

Immediately following the twenty-four (24) hour settling period for final grading of the Dry Swale Facilities, the entire length and width of the Dry Swale Facilities shall be sodded. Sod shall be placed in accordance with 32 92 23, (Sodding) with the following exception: Liming shall not apply.

PART 4 MEASUREMENT AND PAYMENT

A. The payment for the items specified in the Contract Documents will be full compensation for all applicable excavation, sheeting, shoring, dewatering, rototilling, loading, hauling, storing, rehandling of material, removal and disposal of excess and unsuitable material, PPWP, aggregate, geotextile, furnishing, mixing and placement of the BSM backfill, compaction of the BSM backfill by saturation, grading and slope adjustments, water for BSM saturation, mulch, sand, planting soil, sodding and for all material, labor, equipment, tools and incidentals necessary satisfactorily complete the Work.

B. Excavation. Excavation for Surface Sand Filters will be measured and paid for at the Contract Unit Price per cubic yard for the pertinent Class of Excavation.

C. Dewatering and rototilling of the excavated areas for Surface Sand Filters will not be measured but will be incidental to excavation.

D. Geotextile. Geotextile for Surface Sand Filters will be measured and paid for at the Contract Unit Price per square yard for Geotextile Class PE, Type III.

E. Aggregate. Aggregate for Surface Sand Filters will be measured and paid for at the Contract Unit Price per ton for the pertinent Stone Aggregate item.

F. ASTM C33 Fine Aggregate (Sand). ASTM C33 Fine Aggregate (Sand) for Surface Sand Filters shall be measured and paid for at the Contract Unit Price per cubic yard for ASTM C33 Fine Aggregate.

G. PPWP. PPWP for Surface Sand Filters will be measured and paid for at the Contract Unit Price per linear foot for Polyvinyl Chloride Profile Wall Pipe (PPWP). Fittings, manufactured connections and geotextile sleeves will not be measured but will be incidental to the Contract Price.

H. Planting Soil. Planting soil for Surface Sand Filters will be measured and paid for at the Contract Unit Price per cubic yard for planting soil for Surface Sand Filters.

I. BSM. Furnishing, amendments, mixing, mixing of corrective additives, placement, compaction and grading of BSM will not be measured but will be incidental to the Contract Price of planting soil, fine aggregate and mulch.

J. Mulch. Mulch will be measured and paid for at the Contract Unit Price per square yard.

K. Watering. Watering for compaction of Sand and BSM in Surface Sand Filters will be measured and paid for at the Contract Unit Price per one thousand (1000) gallons of water applied to Sand and BSM.

L. Sodding. Sod for Surface Sand Filters will be measured and paid for at the Contract Unit Price per square yard.

M. Discharge from Perforated Pipe System. Any sediment laden water discharged from the perforated pipe system during compaction of the sand and BSM during saturation shall be filtered or removed from the outlet structure and is incidental to completing the Work.

33 44 19.16 INFILTRATION TRENCHES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of installing infiltration trenches as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Class I Riprap: Refer to 31 35 26.24, (Riprap Slope Protection).

B. PVC Pipe, Schedule 40: Refer to 33 41 00, (Storm Water Drains and Sanitary Sewers).

C. Geotextile Class as specified: Refer to 33 46 16.19, (Pipe Underdrains).

D. Stone. Refer to American Association of State Highway and Transportation Officials (AASHTO) M43 No. 2.

PART 3 EXECUTION

3.1 GENERAL

Infiltration trenches shall not be placed in service until all of the contributing drainage area has been stabilized to the satisfaction of the Engineer. Heavy equipment and traffic shall be restricted from the proposed infiltration trench location.

3.2 EXCAVATION

Excavated material shall be removed from the trench site. Trench walls and bottom shall be free of protruding objects that could damage the geotextile. When necessary, the

trench walls shall be sloped. The bottom dimensions and stone depth shall be as specified in the Contract Documents. The sidewalls of the trench shall be roughened. The bottom of the trench shall be graded flat. Refer to 31 23 16.16, (Structure Excavation) for excavated material.

3.3 INSTALLATION

A. Geotextile shall be placed on the sides of the trench and the top of the No. 2 stone. The bottom of the trench shall not be covered with geotextile. The geotextile for the sides of the trench shall overlap the top geotextile by six to eight inches (6″ to 8″). The top geotextile shall extend the full width and length of the trench. All longitudinal joints in the top geotextile shall overlap a minimum of six inches (6″). The upstream roll shall overlap the downstream roll by a minimum of two feet (2′) for a shingled effect.

B. An observation well shall be placed vertically in the longitudinal center of each infiltration trench using a six inch (6″) diameter perforated PVC pipe, Schedule 40. The pipe shall be placed on a base plate at the bottom of the trench. The well shall be capped using a threaded PVC fitting and a vandal proof sewer cap. The cap shall be set six inches (6″) above ground level with the depth of the trench marked on the cap. The well shall have a plastic collar with ribs to prevent rotation when removing the cap. When soil capping is used, the observation well shall be constructed of perforated PVC pipe within the No. 2 stone and nonperforated pipe through the soil capping.

C. All stone shall be clean and free of all soil and fines. The No. 2 stone shall be placed in twelve inch (12″) lifts with no compaction. Care shall be taken to prevent soil and fines from intermixing with the stone aggregate. All contaminated stone aggregate shall be removed and replaced with uncontaminated stone aggregate at no additional cost to the City. The trench shall be capped with a twelve inch (12″) minimum depth of stone or soil as specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

Infiltration Trenches will be measured and paid for at the Contract Unit Price per cubic yard. The payment will be full compensation for all excavation, stone, capping, riprap, geotextile, PVC pipe, fittings, cap, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

33 46 00 SUBDRAINAGE

33 46 16.19 PIPE UNDERDRAINS AND OUTLETS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing underdrains, subgrade drains, underdrain for spring control, underdrain pipe outlets, and blind drains using pipe, geotextile, and granular material as specified in the Contract Documents or as directed by the Engineer. Cleaning existing underdrain outlets is also included in this Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. No. 57 aggregate shall conform to 32 11 23.10, (Aggregate Base Course).

B. Concrete Mix No. 2 shall conform to 03 30 00, (Portland Cement Concrete Structures).

C. Pipe shall conform to 33 41 00, (Storm Water Drains and Sanitary Sewers).

D. Geotextile, Class as specified shall conform to the following:

1. Geotextile Requirements. All geotextiles shall be listed in the National Transportation Product Evaluation Program (NTPEP) for geotextiles. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of a minimum ninety-five percent (95%) by weight of polyolefins or polyesters. The fibers shall be formed into a stable network so that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

2. Geotextile shall conform to the following:

MARYLAND APPLICATION CLASS	TYPE OF GEOTEXTILE	GRAB STRENGTH lb D4632	PUNCTURE STRENGTH lb D4833	PERMITTIVITY Section D4491	APPARENT OPENING SIZE: max mm D 4751	TRAPEZOID TEAR STRENGTH lb D 4533
SD TYPE I	NONWOVEN	160	56	0.50	0.43	55
	WOVEN MONOFILAMENT	250	90	0.50	0.43	90
TYPE II	NONWOVEN	160	56	0.20	0.25	55
	WOVEN MONOFILAMENT	250	90	0.20	0.25	90
PE TYPE I	NONWOVEN	200	80	0.70	0.43	80
	WOVEN MONOFILAMENT	250	90	0.70	0.43	90
TYPE II	NONWOVEN	200	80	0.20	0.25	80
	WOVEN MONOFILAMENT	250	90	0.20	0.25	90
TYPE III	NONWOVEN	200	80	0.10	0.22	80
	WOVEN MONOFILAMENT	250	90	0.10	0.22	90
SE	NONWOVEN	200	80	0.20	0.30	80
	WOVEN	250	90	0.20	0.30	90
ST	WOVEN	300*	110	0.05	0.15**	110
	WOVEN	100	–	0.05	0.60	–
F	NONWOVEN	90	30	0.50	0.30	30
E						

Note 1: All property values are based on minimum average roll values in the weakest principle direction, except for apparent opening size.

Note 2: The ultraviolet stability shall be fifty percent (50%) after five hundred (500) hours of exposure for all classes, except Class F, which shall be seventy percent (70%) (D 4355).

* Minimum fifteen percent (15%) elongation.

** This is a MINIMUM apparent opening size, not a maximum.

3. Only those geotextiles that have been tested by NTPEP will be considered candidates for use. In addition, the geotextiles shall conform to the Contract Documents and to the Geotextile Acceptance and Quality Assurance Procedure, Maryland Standard Method of Tests (MSMT) 732.
4. Geotextiles used for reinforcement applications shall have a separate approval process.

E. Securing Pins or Staples. Securing pins or staples shall have a minimum ten inch (10″) length and shall be designed to securely hold the geosynthetic in place during construction.

F. Flexible Delineator Post and Rodent Screens shall be as approved by the Engineer.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall coordinate the field installation of traffic barriers, signs, lighting, and landscaping with the Engineer to avoid any damage to the underdrains, subgrade drains, or outlet pipes. Any damage to the underdrains, subgrade drains, or outlet pipes shall be corrected to the satisfaction of the Engineer.

3.2 EXCAVATION

Trenches shall be excavated to the dimensions and grade specified in the Contract Documents or as directed by the Engineer. The sides and bottom of trenches shall be smooth and uniform to prevent tearing of the geotextile when backfilling. Refer to Division 31 23 16.16, (Structure Excavation) for excavated material.

3.3 GEOTEXTILE

A. Geotextile, when specified, shall be placed in conformance with the Contract Documents. The machine direction of the geotextile shall be parallel to the longitudinal direction of the trench. The geotextile shall be of sufficient width to completely enclose the underdrain trench including any specified overlaps.

B. The geotextile shall be placed tightly against the underdrain trench to eliminate voids beneath the geotextile. Wrinkles and folds in the geotextile shall be avoided, except when changing trench direction. A minimum twenty-four inch (24″) overlap at the geotextile joint ends or breaks shall be maintained. Geotextile joints and overlaps shall be pinned to securely hold the geotextile in place until placement of the cover material. Longitudinal joints, overlaps and edges shall be pinned a minimum of fifty foot (50′) on center.

C. Damaged geotextile shall be replaced or repaired as directed by the Engineer at no additional cost to the City.

3.4 PIPE PLACEMENT

Underdrain pipe shall be placed in conformance with the Contract Documents. The slope of the underdrain pipe shall be so that positive drainage toward the underdrain outlet is maintained. Perforated pipes shall be placed with the perforations down and arranged symmetrically about the vertical axis. The ends of trunk lines, wye, tee, or elbow laterals

shall be plugged as directed by the Engineer. Joints and connections shall be in conformance with the manufacturer's recommendations.

3.5 OUTLETS

A. Underdrain outlets shall be constructed in conformance with the Contract Documents.

B. Underdrains shall be outletted into drainage structures whenever possible. Outlets that empty into a drainage structure shall be positioned a minimum of six inches (6″) above the normal flow level in the structure and shall be constructed of normal underdrain pipe. A minimum of eighteen inches (18″) of cover over the pipe shall be maintained. A rodent screen is not required when an underdrain is outletted into a drainage structure.

C. When outletted to a slope or ditch, the outlet pipe shall slope a minimum of three percent (3%) unless otherwise directed by the Engineer. Pipe used for outlets shall be plain, rigid polyethylene (PE), or plain, rigid polyvinyl chloride (PVC) as specified in 33 41 00, (Storm Water Drains and Sanitary Sewers). Flexible tube type PE or PVC pipe is prohibited. Geotextile is prohibited for underdrain outlets. A sloped concrete headwall with a removable rodent screen shall be constructed at the end of the outlet pipe in conformance with the Contract Documents. A flexible delineator post shall be placed on the slope headwall unless otherwise directed by the Engineer.

D. Outlets for longitudinal underdrains shall be spaced at two hundred fifty foot (250′) maximum intervals, unless otherwise directed by the Engineer, and at the lowest elevation on all vertical curves. When changing the direction of the longitudinal underdrain or outlet pipe, all bends in the pipe shall have a minimum radius of three foot (3′) to facilitate future cleaning.

3.6 BACKFILL

A. Documents. Underdrain and outlet trenches shall be backfilled as the Work progresses unless otherwise directed by the Engineer.

1. Underdrain. Aggregate backfill shall be lightly tamped and screened or raked to provide proper thickness and grade.
2. Outlets. Backfill shall conform to 31 23 23.10, (Tamped Fill).

B. The Contractor shall replace any geotextile, underdrain pipe, or outlet pipe damaged by excessive tamping.

C. Longitudinal underdrain shall be covered with the next pavement layer within seventy-two (72) hours. All other underdrain shall be covered within forty-eight (48) hours. The Contractor shall protect underdrain, including the geotextile, from contamination by soil fines. Any underdrain trench that becomes contaminated and any geotextile that becomes clogged, shall be replaced or repaired as directed by the Engineer at no additional cost to the City.

3.7 VIDEO INSPECTION AND ACCEPTANCE

All new longitudinal underdrain and outlets shall be video inspected by the Contractor in the presence of the Engineer as part of final acceptance. When any damage is found it shall be corrected to the satisfaction of the Engineer at no additional cost to the City.

3.8 CLEANING EXISTING OUTLETS

A. Existing underdrain pipe outlets shall be cleaned and the material disposed of as directed by the Engineer. Existing rodent screens shall be removed and replaced and where there are no screens, rodent screens shall be installed as directed by the Engineer.

B. Existing rodent screens damaged due to the Contractor's negligence shall be replaced at no additional cost to the City.

3.9 PERMANENT SUBGRADE DRAINS

Permanent subgrade drains shall be required when specified in the Contract Documents or as directed by the Engineer. Subgrade drains shall consist of trenches excavated through the shoulder and roadside grading from the edges of the road pavement to a side ditch, embankment slope, or other approved outlet and filled with aggregate. Locations, unless otherwise specified, shall be at low points and shall be spaced at twenty-five foot (25′) intervals for a distance of one-hundred twenty-five foot (125′) on each side of the low point, then at intervals of one hundred foot (100′) to within one-hundred twenty-five foot (125′) of the high point. Before placing the road pavement and before completion of the shoulder paving or final roadside grading areas, trenches shall be cut and shaped twenty-four (24″) inches wide, backfilled to underside of shoulder material and to the underside of specified topsoil thickness in the roadside grading area using size No. 57 aggregate. The portion of the trench within the roadside grading area shall be completely wrapped in geotextile. The bottom of the trench at the end adjacent to the road pavement shall be at least two inches (2″) below the subgrade unless otherwise directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, pipe, coupling bands, aggregate, backfill, geotextile, video inspection and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Underdrains, underdrain pipe outlets, subgrade drains, and underdrain pipe for spring control will be measured and paid for at the Contract Unit Price per linear foot.

C. Slope headwalls, rodent screens, and marker posts will not be measured but will be incidental to the cost of the underdrain outlet.

D. When an underdrain pipe is not used for spring control, all excavation and backfill for spring control will be measured and paid for at the Contract Unit Price per cubic yard for Class 3 excavation for incidental construction and aggregate backfill for underdrain.

E. When directed by the Engineer, excavation for underdrains, subgrade drains, and underdrain for spring control required to lower the trench to an elevation deeper than specified in the Contract Documents will be measured and paid for at the Contract Unit Price per cubic yard for Class 3 excavation for incidental construction and aggregate backfill for underdrain.

F. When measuring the length of a manufactured connection (tee, elbows, etc.) other than coupling bands, each actual linear foot will be doubled and payment made at the Contract Unit Price per linear foot for the appropriate underdrain pipe item specified in the Contract Documents.

G. Cleaning existing underdrain outlets will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for locating outlets, removing and replacing the existing rodent screens, removal and disposal of material removed from the pipe, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

33 49 00 STORM DRAINAGE STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing miscellaneous cast in place concrete or masonry structures, and installing precast concrete structures as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mortar sand shall conform to 03 30 00, Part 2.1, C, (Portland Cement Concrete Structures).

B. Concrete Mix No. 2, No. 3 or No. 6: Shall conform to 03 30 00, Part 2.1, G, (Portland Cement Concrete Structures).

C. Grout shall conform to 03 30 00, Part 2.1, H, (Portland Cement Concrete Structures).

D. Brick used for channel lining shall be shall conform to M 91, Grade SM. All other brick utilized in drainage structures and manholes shall be manhole brick, Grade MS.

E. Reinforcement steel shall conform to 03 30 00, Part 2.1, K, (Portland Cement Concrete Structures).

F. Steel for miscellaneous use shall conform to A 36 or A 709, Grade 36.

G. Castings for Frames, Covers, Gratings and Steps: Iron castings shall conform to A 48, Class 30B. Covers shall be labeled in accordance with the Standard Details. Steps and ladders shall be as dimensioned on the Standard Details. Manhole and inlet steps shall conform to A 312 Grade TP 410 Stainless steel.

H. Zinc coating shall conform to A 153.

I. Stone shall conform to M 43 Size No. 57.

J. Precast Concrete End walls, inlets, and manholes shall conform to M 199.

K. Waterproofing for exterior of manholes and miscellaneous structures shall be as specified in the Contract Documents and 03 15 13, (Dampproofing and Waterproofing).

PART 3 EXECUTION

3.1 GENERAL

Refer to 03 30 00, (Portland Cement Concrete Structures), 04 21 13, (Brick Masonry) for brick masonry, and 31 23 16.16, Part 3.2, (Structure Excavation) for excavated material.

3.2 CONSTRUCTION SEQUENCE

Underground drainage structures shall be completed before roadway surfacing is placed. Manholes, catch basins and inlets shall not be completed to final grade until the grading has been finished and all necessary arrangements have been made to ensure suitable connections and tie ins at proper grade and alignment with pavements, gutters and curbs.

3.3 CASTINGS

A. Frames for grates and covers for inlets and manholes, shall be set in full beds of mortar and rigidly secured in place to proper grade and alignment as specified in the Contract Documents. Adjust the frame to proper grade by using precast concrete grade rings or brick masonry when structure is in space dedicated for public use, traveled way or when designated to meet existing grade. Transition shall be a minimum of four inches (4″) and a maximum of eighteen inches (18″) high. Otherwise precast structures shall be built without transition. Frames shall be adjusted to within five one-hundredths of a foot (0.05′) of surface in existing paved areas and within one-tenth of a foot (0.10′) of the approved surface grade in future paved areas.

B. The covers, grates, etc. shall fit neatly into their respective frames; and that all similar sized frames and grates or covers shall be completely interchangeable. Covers and grates will not be permitted to rock in the frame and sufficient metal shall be provided in pouring the casting so that all blisters or imperfections are removed by grinding or machining or bearing surfaces as indicated on the Contract Drawings. The top surface of rims of cover, grate and frames shall be flush when installed. Frames, grates and/or covers shall be shipped to the project site in matched sets and installed in the same manner.

C. The frame shall be set in a bed of mortar of not less than one inch (1″) as shown on the Standard Details and as specified hereinafter:

1. Brick Masonry Transition: The exterior of the brick shall be parged with mortar applied in one (1) coat, three-eighths inch to one-half inch (3/8″ inch to 1/2″) thick. Each parge coat shall be cured for a minimum of six (6) hours. Parging shall extend a minimum of six inches (6″) below top of cone section and cover the top of the brick to the interior face of the manhole wall. A bed of mortar not to exceed one inch (1″) in thickness may be added to the top of the brick in addition to the parge coats to fine grade the frame with the approved surface grade.
2. Precast Concrete Grade Ring Transition: Provide precast concrete grade rings for circular frames, three inches (3”) through six inches (6”) thick. If required to meet proper grade, one (1) split grade ring, two inches (2”) thick, may be used provided this does not exceed the maximum transition heights. Precast concrete

grade rings shall be set in full beds of Type M mortar not less that one-quarter inch (1/4") nor more than one and one-quarter inch (1-1/4") thick horizontal circumferential and vertical mortar joints, inside and outside, shall be pointed with full with. Depth of pointing shall not exceed three-eighths inch (3/8"). The mortar shall be cured a minimum of six (6) hours prior to backfilling and the setting of the circular frame.

3. Frame and Cover Placement Without Transition: Place frame in a bed of mortar not less than one inch (1") in thickness.

3.4 PIPE CONNECTIONS

Inlet and outlet pipes at drainage structures shall be set or cut flush with the inside faces of the structures and shall extend a sufficient distance beyond the outside faces of these walls to provide ample room for making proper connections. The joint around the pipe in the structure wall shall be completely and neatly closed with mortar or other specified materials.

3.5 INVERTS

Provide appropriate flow channel/bench in the bottom of structures. The channel width and height shall match the inside diameters of incoming and outgoing pipes, blended to a smooth contour so storm water flows will traverse smoothly between the different pipes in accordance with the Drawings and Standard Details. Brick channel/bench shall be as specified for masonry work for utilities in 04 21 13, (Brick Masonry).

3.6 DRAINAGE STRUCTURES

Inlets and manholes shall contain two (2), eight inch (8") minimum diameter blockouts for underdrains. The drainage structures shall be backfilled with No. 57 aggregate for a width of one and one-half foot (1.5') outside of the structure and extend from the bottom of the structure to the subgrade. Construct inlets and manholes of precast sections, cast in place concrete, brick or concrete block and parge in accordance with Standard Details and the Drawings.

3.7 PRECAST DRAINAGE STRUCTURES

A. Working Drawings for structures not detailed in the Contract Documents shall be submitted to the Engineer for approval prior to fabrication.

B. Certification: Certification from the manufacturer for each shipment of precast units is required. A copy of the certification shall be delivered to the Engineer and the Contractor with each shipment. One (1) copy shall remain at the plant. The certification shall contain the name and address of the manufacturer, the type of structure, the identification number, the date of manufacture, the date of shipment, a statement indicating conformance with the Specifications, and the signature of the quality control manager. Noted on the unit shall be the station number and designation, the identification number, the name or trademark of the manufacturer, the date manufactured, and a stamp indicating conformance with the Specifications.

C. No precast unit shall be shipped unless it has been tested and is shown to be in full compliance with the Contract Documents. Plant accepted precast sections shall be

protected from damage while in storage at the plant, in transit and at the Contract site. They shall be handled with proper size equipment using only appropriate lifting holes or eyes. Joint ends of the sections shall be kept clean and placed on wood blocks, pallets, or other appropriate material, never on the ground. If damage is evident, it shall be repaired or the section rejected, as directed by the Engineer. Thoroughly clean joint surfaces, remove all debris and foreign matter, and keep joint surfaces clean during assembly. Use rubber gasket, mastic or nonshrink mortar to joint the sections.

D. Precast sections shall be installed in accordance with the Manhole Manufacturer's written assembly instructions.

E. Precast sections damaged beyond acceptable repair after plant acceptance and prior to acceptance after installation will be rejected and shall be removed and replaced at no expense to the City. Damage that is repairable shall be repaired by manufacturer in accordance with its recommended repair methods and in the presence of the Engineer.

F. The placement and consolidation of the required bedding under the unit shall be a minimum six inch (6″) of No. 57 aggregate unless otherwise directed by the Engineer.

3.8 MASONRY DRAINAGE STRUCTURES

A. Brick drainage structures shall be constructed in accordance with 04 21 13, (Brick Masonry).

B. Unless otherwise specified, collars for brick curves shall extend along connecting pipes for a distance equal to upper wall thickness of the respective brick curve.

3.9 CONNECTIONS TO EXISTING STORM DRAINS

A. Certain information is shown on the Drawings relative to existing storm drain pipe, manholes and appurtenances. This information was transferred from existing records and is deemed to be reliable but the City does not warrant or guarantee that the location, dimensions and type of material existing are exactly as shown. Before installing pipe under this Contract, verify by test pits or other means the detailed requirements for making the proposed connection to existing storm drain.

B. Maintaining existing storm water flows during connection to existing storm drain is the responsibility of the Contractor. Precautions and methods to divert storm water shall be taken and employed as required. Storm water backup damage and/or clean up required due to the Contractor's operations shall be the responsibility of the Contractor. When working on an existing storm drain, provide the required materials, screening devices and take appropriate measures to cover or otherwise keep solid material from entering the sewage flow. Remove and dispose of solid and waste material as required.

C. When connecting a pipe to an existing manhole, seal the pipe in the existing manhole wall with quick setting nonshrink grout. Excavation shall be kept dry and not be backfilled before eight (8) hours have elapsed.

D. When a manhole is built on an existing storm drain, cut existing pipe and maintain storm water flow by diverting or pumping during installation.

3.10 PIPE ENCASEMENT

Pipe encasement shall be Mix No. 1 Concrete unless otherwise specified. The thickness, shape and controlling dimensions shall be as shown on the Plans and/or Standards.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, concrete, masonry, special or precast units, reinforcement, ladder rungs, drip stones, No. 57 aggregate, underdrain stubs, frames, grates and covers, grade and slope adjustments, backfill and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Standard inlets and manholes specified in the Contract Documents will be measured and paid for at the Contract Unit Price per linear foot of vertical depth for each type of unit built to the dimensions shown on the Standard plates, plus any additional vertical depth directed by the Engineer. The base bottom thickness for each unit shall not be included in the measurement.

C. The measurement of length of brick curves will be measured on the basis of linear foot of the centerline length of the curve from P.C. to P.T. Payment will be made on the basis of unit price Bid per linear foot, which price shall include cost of collars required to connect curves to adjoining pipes and/or structures.

D. Standard end walls, headwalls, end sections and special structures will be measured and paid for at the Contract Unit Price per each.

E. Nonstandard end walls and other miscellaneous structures such as steps, spring boxes, and junction boxes, constructed using brick masonry or concrete will be measured and paid for at the Contract Unit Price per cubic yard unless otherwise specified in the Contract Documents.

F. No separate or additional measurement will be made for any precast concrete units, metal or castings used in the construction of any of the items noted above.

G. When an existing drainage structure is to be removed and replaced with a new drainage structure in the same location, the cost to remove the existing drainage structure and a section of the existing pipe will be incidental to the cost of the new drainage structure.

DIVISION 34
TRANSPORTATION

34 01 00 OPERATION AND MAINTENANCE OF ROADWAYS

34 01 13.10 TRAFFIC CONTROL PLAN (TCP)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of the development and implementation of a TCP. The TCP will include the design and placement of items such as signing, pavement markings, delineation, channelization, barriers, crash cushions and other items as required.

B. TCP's may be implemented within a single project or jointly between two (2) or more projects. In situations where TCP's are jointly implemented, care shall be exercised to present correct and nonconflicting guidance to the traveling public.

C. The Contractor shall implement the City's TCP (Option 1) or may modify the City's TCP (Option 2) or develop its own TCP (Option 3). The Contractor's TCP shall be submitted in writing to the Engineer at least twenty (20) days prior to starting any Work. Changes to the approved TCP shall be submitted in writing at least five (5) days prior to implementing the change. For emergencies the approval process will be completed within several hours. The Contractor shall have written approval of any TCP changes from the Engineer prior to their implementation. No Work shall begin until the required traffic control patterns and devices are in place.

D. Work Restrictions. The Engineer reserves the right to modify or expand the methods of traffic control or working hours as specified in the Contract Documents. Any request from the Contractor to modify the Work restrictions shall require written approval from the Engineer at least seventy-two (72) hours prior to implementing the change. The Contractor shall submit a copy of the original Work restrictions with the written request.

E. Work is not permitted on Saturdays or Sundays.

F. Work is not permitted on the holidays, or Work day preceding and following holidays indicated below with an "X":

- ☐ New Year's Day, January 1
- ☐ Martin Luther King's Birthday, the third Monday in January
- ☐ President's Day, the third Monday in February
- ☐ Good Friday
- ☐ Easter Weekend
- ☐ Memorial Day, the last Monday in May
- ☐ Independence Day, July 4
- ☐ Labor Day, the first Monday in September
- ☐ Columbus Day, the second Monday in October
- ☐ Veteran's Day, November 11
- ☐ Thanksgiving Day, the fourth Thursday in November
- ☐ Christmas Day, December 25

TEMPORARY LANE OR SHOULDER CLOSURE SCHEDULE			
ROADWAY	# LANE(S) / SHOULDER CAN BE CLOSED	DAY of the week	Closure Period (TIME OF DAY)

G. When a temporary lane or shoulder closure is in effect, Work shall begin within one (1) hour after the lane is closed. Any delay greater than one (1) hour with no Work in progress shall require the Contractor to remove the lane closure at no additional cost to the City. The Contractor's traffic manager shall attend preconstruction and prepaving meetings and shall discuss traffic control and the traffic control plan including procedures to be implemented for lane closures.

H. All closures shall be in conformance with the approved TCP and under the direction of the Contractor's traffic manager and the Engineer.

I. All temporary lane or shoulder closures shall be restored at the end of the closure period and no travel lane shall be reduced to less than ten feet (10'). Prior to opening the closed lane or shoulder, the Contractor shall clear the lane or shoulder of all material, equipment and debris.

J. Failure to restore full traffic capacity within the time specified will result in a deduction being assessed on the next progress estimate in conformance with the following. This is in addition to the requirements specified in 01 29 76, (Progress Payment Procedures).

ELAPSED TIME, MINUTES	DEDUCTION
1–5	$ 50.00
Over 5	$ 50.00 per Minute (In addition to the Original 5 minutes)

K. When TCP Option 2 or Option 3 has been selected by the Contractor on the traffic control plan certification form included in the documents, the following shall apply:

1. Plans or revisions to Plans submitted for approval shall be drawn to the same degree, likeness and sophistication as that of the Contract Plans.
2. Submittals shall be on sheets measuring twenty-two inches by thirty-four inches (22″ X 34″) with a standard margin and a standard title block at the lower right corner approximately four inches by eight inches (4″ X 8″) or on eight and one-half inches by eleven inches (8-1/2″ X 11″) paper with a one inch (1″) margin and a title block.

   a. The title block shall contain the following information in the order listed.

      Name of Contractor (and Subcontractor, if applicable)
      Address of Contractor (and Subcontractor, if applicable)
      Sheet Title
      City Contract Numbers and
      Complete Federal Aid Number, if any
      "Prepared for Baltimore City" Signature block for approval by Contractor's traffic manager and date of approval.

3. All lines shall be clean, sharp, solid and heavy enough to permit adequate reproduction. The scale of phase details on the TCP shall be one inch (1″) equals one hundred feet (100′). Additional Plans that revise the design Plans shall be at the same scale as the Contract Plans.
4. The use of white pigment to cover lines is prohibited.
5. Plans shall indicate the proposed traffic movements throughout the area affected by the Work for each phase of Construction, have all routes labeled, show north arrow, and any other information that would clarify the TCP.

L. Any monetary savings from changes to the TCP made by the Contractor and approved by the Engineer will be divided equally between the Contractor and the City.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

Not applicable.

PART 4 MEASUREMENT AND PAYMENT

Any traffic control plan developed by the Contractor will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

34 01 13.15 SAW CUTS FOR TRAFFIC CONTROL DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of saw cutting and sealing the saw cuts for traffic control devices, within and alongside the roadway, between the detector location and the nearest terminal point as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Sealer shall conform to 10 14 53.01, Part 2.1, B, (Traffic Control Electrical Cable Wire and Connectors).

PART 3 EXECUTION

3.1 SAW CUT

Prior to saw cutting, holes shall be drilled at all turns as specified in the Contract Documents. All saw cuts shall be made utilizing a water-quenched process. Saw cutting curbs and gutters is prohibited. The saw cut width shall be as specified in the Contract Documents.

3.2 SAW CUT SEALING

Sealer used to seal saw cuts shall be applied as specified in the manufacturer's recommendations into washed, cleaned, and dried saw cuts. The saw cuts shall not be sealed until electrical testing is performed as specified in 26 07 01.03, (General Electrical Work and Testing). Sealer shall not be poured when the roadway surface temperature is below thirty-five degrees (35°) F or during any precipitation.

PART 4 MEASUREMENT AND PAYMENT

Saw Cuts for traffic control devices will be measured and paid for at the Contract Unit Price per linear foot. The payment will be full compensation for all drilled holes, washing, cleaning, drying, sealing and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 01 13.20 FLAGGER

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing flaggers when specified in the Contract Documents or as directed by the Engineer. Flagging shall conform to MUTCD. All outfits and equipment (Stop/Slow paddles, pilot cars or other vehicles, air horns or bull horns, field telephones, two-way radios, site illumination, etc.) will be subject to the approval of the Engineer. Flaggers shall have completed a City approved flagger training course within the last three (3) years. The failure of any flagger to perform the required duties shall be grounds for the Engineer to require a replacement.

B. Two-way radios, field telephones or pilot vehicles shall be used whenever flaggers are not within sight distance of each other or when directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

Paddles shall be twenty-four inches by twenty-four inches (24″ X 24″) with minimum eight inch (8″) high letters. Reflective sheeting on the Stop/Slow paddle shall conform to 10 14 53, (Signs).

PART 3 EXECUTION

Flaggers shall use Stop/Slow paddles unless otherwise permitted by the Engineer. Standard paddle sign designs shall be as specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

A. Flagger will not be measured but the cost will be incidental to the Contract Price for maintenance of traffic unless otherwise specified in the Contract Documents.

B. When an item for flagger is specified in the Contract Documents, the flagger will be measured and paid for at the Contract Unit Price per hour unless otherwise specified in the Contract Documents. The payment will be full compensation for clothing and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 01 13.30 TRAFFIC MANAGER (TM)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing a traffic manager (TM) as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. The Contractor shall submit the TM's name to the Engineer for approval at least 10 days prior to commencing any Work on the project. The TM shall provide proof of completing a City approved temporary traffic control (TTC) training course within the last three (3) years. Change in the appointment of any TM throughout the duration of the Contract will require a written submission to the Engineer for approval. The TM's failure to perform the required duties shall be grounds for the Engineer to require a replacement.

B. The TM shall implement the traffic control plan (TCP), maintain an up to date TCP and provide a copy to the Engineer following any changes.

C. The TM shall closely coordinate the operations with the Engineer and shall supervise the maintenance of traffic on the project, including those involving Subcontractors. The TM shall make on-site inspections of the area affected by the Work on a regular basis including Saturdays, Sundays and holidays and be available for consultation at all times. When the TCP is in place, the TM shall be responsible for making daily inspections during hours of operations and a minimum of one (1) night inspection per week. More inspections may be required as directed by the Engineer. The monitoring of the maintenance of traffic by the TM shall include surveillance of any area affected by the Work of the Contract during holiday periods. The TM shall maintain a daily log for the inspections and shall include the date, time, hours worked, condition of maintenance of traffic and any corrective action taken. A copy of the daily log shall be furnished to the Engineer by the following day.

D. The TM shall also be responsible for coordination between adjacent Work zone operations to ensure that inappropriate or conflicting traffic control sign messages or devices are not displayed to traffic.

E. The TM shall immediately notify the Engineer of any accident or incident within the area affected by the Contract.

F. The TM shall make inspections during and immediately after adverse weather conditions to ensure that the traffic control devices are clean, undamaged, and in their proper positions.

PART 4 MEASUREMENT AND PAYMENT

The traffic manager will not be measured but the cost will be incidental to the Contract Price for maintenance of traffic.

34 41 00 TRANSPORTATION SIGNALING AND CONTROL EQUIPMENT

34 41 00 ROADWAY SIGNALING AND CONTROL EQUIPMENT (MAINTENANCE OF TRAFFIC)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of maintaining vehicular and pedestrian traffic on or along any transportation facility as specified in the Contract Documents. This Section sets forth the traffic control requirements necessary for the safe and continuous maintenance of traffic throughout the area affected by the Work and is intended to minimize inconveniences to the traveling public, while providing for the safety of motorists, pedestrians and workers.

B. When the speed of traffic is noted, this means the posted speed or prevailing travel speed; whichever is higher, unless otherwise specified.

C. Items used for temporary maintenance of traffic shall be removed from the project site when no longer needed and become the property of the Contractor, unless otherwise specified in the Contract Documents.

D. Ninety percent (90%) of all reflective barrier markers, warning lights and raised pavement markers shall be operational at any given time unless the Engineer specifies more. Any deficiencies shall be corrected within twenty-four (24) hours.

E. Upon initial installation reflectorized traffic control signs shall have a minimum of 70 percent reflectivity specified in 2.1.B over ninety percent (90%) of their reflectorized surface and channelizing devices shall have a minimum of 80 percent reflectivity specified in 2.1.B over 90 percent of their reflectorized surface.

F. The Contractor shall replace damaged traffic control devices, such as yield or stop signs, within four (4) hours of notification by the Engineer. The Contractor shall take the necessary corrective action as approved by the Engineer to adequately warn and protect the public until the signs are replaced.

G. When Work is specified to be accomplished under the maintenance of traffic item, the Work will be incidental to the Contract Price for maintenance of traffic.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast concrete traffic barrier: Refer to 34 71 13.20, (Temporary Concrete Traffic Barrier (TCB) for Maintenance of Traffic).

B. Reflectorization of signs and channelizing devices: Refer to 10 14 53, (Signs).

C. Overhead sign structures: Refer to 10 14 15.04, (Overhead Sign Structures).

D. Backfill material for trenches for buried cable: Refer to 34 41 16.06, (Trenching and Backfill for Traffic Controls).

E. Electrical cable and wire: Refer to 10 14 53.01, (Electrical Cable, Wire and Connections).

F. Lighting structures: Refer to 26 56 13, (Lighting Structures).

G. Signs: Refer to 10 14 53, (Signs).

H. Steel spanwire: Refer to 34 41 13.20, (Steel Span Wire).

I. Conduit: Refer to 26 07 01.01, (Electrical Conduit and Fittings).

J. Electrical conduit detector tape: Refer to 34 41 16.06, (Trenching and Backfilling for Traffic Controls).

K. Luminaires and lamps: Refer to 26 50 01, (Luminaires and Lamps).

L. Control and distribution equipment: Refer to 34 41 16.08, (Traffic Control Device Cabinets and Equipment).

M. Traffic signal heads: Refer to 34 41 13.30, (Traffic Signal Heads).

PART 3 EXECUTION

3.1 MAINTENANCE OF EXISTING ROADWAY

A. The Contractor shall be responsible for maintaining the existing roadway surface and shoulders, including crossroads, ramps, approaches, crossovers, medians, detour roads, entrances and pavement markings within the limits of the project, throughout the duration of the Contract.

B. Any hazardous condition which exists or develops throughout the duration of the Contract, such as potholes or shoulder defects, shall be repaired or patched by the Contractor as directed by the Engineer.

3.2 EXISTING REGULATORY SIGNS, WARNING SIGNS, GUIDE SIGNS AND PAVEMENT MARKINGS

A. Existing signs that are not applicable due to temporary traffic conditions shall be relocated when necessary, turned or completely covered with opaque material, or removed with the

approval of the Engineer. They shall be properly redisplayed to traffic as soon as conditions warrant. The Contractor shall replace any existing signs misplaced or damaged by the Contractor's operations at no additional cost to the City.

B. The Contractor shall inventory the locations of all existing pavement markings including legends and symbols with the Engineer prior to Construction. The inventory shall include type, size, location and color to be submitted to the Engineer. The Contractor may mark up a set of Contract Plans or submit their own sketches or Drawings.

3.3 STORAGE AND MOVEMENT OF EQUIPMENT, MATERIAL AND VEHICLES

A. No equipment or material shall be stored or permitted to stand in unprotected areas or open areas within thirty feet (30′) from where traffic is being maintained unless protected by traffic barriers. The Contractor's employees shall not park their vehicles within the right-of-way of the through highway, unless written permission for the Engineer gives an exception. All equipment, material, storage and parking areas shall have advance written approval from the Engineer. Storage of equipment and material may be permitted closer than thirty feet (30′), subject to the following restrictions:

1. Approved temporary traffic barrier shall be in place prior to storage of any equipment or materials.
2. Equipment and material are prohibited from being within four feet (4′) behind the face of the traffic barrier.
3. No equipment or material shall be stored or standing in open areas closer than thirty feet (30′) from where traffic is being maintained, unless the equipment or material is stored in conformance with the AASHTO Roadside Design Guide.

B. Areas used for storage of equipment and material shall be restored to their original condition immediately upon completion of their use. No additional compensation will be provided for this Work.

C. Vehicles and equipment shall enter and leave the Work area in the direction of traffic flow.

D. Work performed on, or adjacent to, the traveled way shall be performed in the direction of traffic flow unless written approval is obtained from the Engineer prior to beginning the Work.

E. The Contractor's vehicles and equipment shall enter on and exit from the roadway at interchanges or legally allowed public use crossovers. Making U-turns across any medians or crossovers signed "FOR USE OF AUTHORIZED AND EMERGENCY VEHICLES ONLY" by the Contractor's vehicles or equipment is prohibited unless the Engineer grants approval in writing.

3.4 WARNING LIGHTS AND DEVICES

Warning lights and flags shall be used on warning signs as specified in the TCP, the Contract Documents, or as directed by the Engineer. During hours of darkness, any channelizing device used to warn of a spot hazard shall have one (1) Type A, low intensity flashing warning light attached to the side adjacent to traffic. Two (2), Type A, low intensity flashing warning lights shall be attached to the top of each Type III barricade.

3.5 GENERAL REQUIREMENTS FOR TEMPORARY PAVEMENT MARKINGS (TPM)

A. For pavement marking dimensions refer to the Pavement Marking Dimension Table reference 3.6 J below.

1. Temporary pavement markings are those markings placed upon the roadway to serve an area of Work activity or a Work phase for a period of time after which they are to be removed. When approved by the Engineer, a less than full complement of pavement markings and reduced dimension markings for dashed centerlines and lane lines may be permitted. Where less than a full complement of pavement markings or reduced dimension markings is used, the time of use shall not exceed two (2) weeks.
2. TPM's may be either full dimension or reduced dimension as specified in the Contract Documents or as directed by the Engineer.
3. Full dimension TPM's shall conform to the MUTCD and the pavement marking dimension table reference 3.6 J below.
4. Reduced dimension TPM's shall conform to the MUTCD and the pavement marking dimension table reference 3.6 J below, except that the dashed center lines and lane lines may consist of four foot (4′) segments and thirty-six foot (36′) gaps. All other dimension elements shall be as specified in the MUTCD and the pavement marking dimension table.
5. TPM's generally use short-lived marking materials that are easily removed. Material requirements are described elsewhere in these Specifications.

3.6 SPECIFIC REQUIREMENTS FOR TPM's

A. As a minimum at the close of each day, the roadway shall have all center and lane lines in place.

B. During the Work day while Work activity is underway, center and lane lines shall be in place or the lines shall be represented by channelizing devices, signs or other traffic control devices to clearly define and mark all vehicle paths.

C. Along two (2) lane, two-way roadways, the center line shall consist of a continuous double solid yellow center line, a single dashed yellow center line at full dimension or a single dashed yellow center line at reduced dimension as directed by the Engineer.

D. No passing zones shall be marked and signed as specified in the Contract Documents or as directed by the Engineer. All no passing zones may be identified by signing for a period not to exceed seven (7) days.

E. Along multilane, undivided roadways the centerline shall be identified using a continuous double solid yellow line. If a two-way left turn is present, see paragraph 3.6.F below. If the roadway is three (3) lanes, the center line may be either a continuous double solid yellow center line or, where passing is permitted in the single lane direction, a continuous single solid yellow and single dashed yellow combination center line. For the placement of no passing zones see paragraph 3.6.D above.

F. Along multilane undivided roadways having a two-way left turn lane, the two-way left turn lane need not be marked provided that channelizing devices are used continuously throughout the length of the left turn lane at a maximum spacing of two hundred feet (200′)

to delineate the left turn lane, separate the opposing flows of traffic and provide areas within which left turning vehicles may store while awaiting opportunities to turn.

G. Along multilane roadways having reversible lanes, the lanes shall be marked with the full compliment of pavement markings as described in the MUTCD.

H. Where edge lines are not in place, appropriate channelizing devices or other delineation shall be used to delineate the edge of the roadway.

I. Specific pavement marking and complimentary signing details are shown on the Temporary Traffic Control (TTC) Typical Applications.

J. Contact the Engineer for the latest approved Temporary Pavement Markings materials.

PAVEMENT MARKING DIMENSION TABLE

LINE TYPE	MATERIAL	REQUIRED MINIMUM EFFECTIVE WIDTH, inches	
		EXPRESSWAYS AND FREEWAYS	OTHER ROADWAYS
Lane Lines	Paint	5	5
	Preformed Tape	4	4
Lane Shifts, Lane Divides and Severe Alignment Changes	Paint	10	5
	Preformed Tape	5	5
Center Lines * See Note	Paint	5 (if operated two-way)	5
	Preformed Tape	4 (if operated two-way)	4
Edge Lines	Paint Preformed Tape	Same as adjacent lane or shift line	Same as adjacent lane or shift line
Ramp Edge Lines	Paint	5	5
	Preformed Tape	4	4
Gore Marking	Paint	10	—
	Preformed Tape	10	—
Auxiliary	Paint Preformed Tape	Same as particular line being extended	Same as particular line being extended

Note: Discernible space between double lines shall be four to five inches (4″ to 5″).

3.7 CHANNELIZING DEVICES

A. When channelizing traffic the requirements shall conform to the MUTCD and the following:

1. Maximum spacing in feet for channelizing devices in a taper shall be the posted speed limit.
2. Maximum spacing in feet for channelizing devices in a tangent shall be twice the posted speed limit in mph.

3. Channelizing devices shall be spaced at twenty-five feet (25′) intervals to define interchange gore areas or other unusual highway alignments, unless a closer spacing is directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Unless otherwise specified, maintenance of traffic will not be measured but will be paid for at the Contract lump sum price. The payment will be full compensation for relocating, turning, completely covering and uncovering or removing and resetting, maintaining in like new condition and cleaning all existing and temporary traffic signs, and any other traffic control device. Also included is the inventory of all existing pavement markings and the treatment of any other traffic control device not included in these Specifications but necessary for the fulfillment of the Contract requirements and implementation of the approved traffic control plan and for all material, labor, equipment, tools, and incidentals necessary to complete the Work. Payment of the Contract lump sum price will be prorated and paid in equal amounts on each monthly estimate. The number of months used for prorating will be the number estimated to complete the Work.

1. When additional Contract pay items for maintenance of traffic are specified in the Contract Documents, measurement and payment will conform to the pertinent pay items included in the Contract Documents.
2. Cones, reflective collars, anchoring devices, stop/slow paddles, sign flags and warning lights will not be measured but the cost will be incidental to the Contract Price for maintenance of traffic unless otherwise specified in the Contract Documents.
3. Temporary traffic control devices, which in the Engineer's opinion need replacement, shall be replaced immediately by the Contractor. The cost to replace traffic control devices, including all material, labor, equipment and tools, will not be measured but will be incidental to the Contract Price for maintenance of traffic except when specifically set up in the Contract Documents as a separate Contract pay item.
4. Material, equipment and labor necessary for the Construction and removal of temporary or detour roads will be measured and paid for at the Contract Unit Price for the pertinent items used.

B. When specified in the Contract Documents, maintenance of traffic will be measured and paid for at the Contract Unit Price per unit day.

C. When there is no item in the Contract Documents, maintenance of traffic will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents.

34 41 13 TRAFFIC SIGNALS

34 41 13.10 SIGNAL STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of the pickup and the installation of City furnished signal structures of the sizes specified in the Contract Documents or as directed by the Engineer. The anchor bolts; grommets and miscellaneous hardware will be furnished by the City.

PART 2 PRODUCTS

2.1 MATERIALS

Signal Structures hardware shall be furnished by the City.

PART 3 EXECUTION

A. The signal structure shall be installed on a concrete foundation conforming to 10 14 15.02, (Concrete Foundations for Traffic Signals) and as specified in the Contract Documents.

B. Breakaway Base Support Systems, when specified, shall conform to 10 14 15.08, (Breakaway Base Support Systems).

C. Any finish on the signal structures and mounting hardware damaged during transportation and erection shall be repaired to match the original finish by the Contractor as approved by the Engineer at no additional cost to the City.

PART 4 MEASUREMENT AND PAYMENT

A. Installation of City furnished signal structures will be measured and paid for at the Contract Unit Price per each for the type of structure erected in place. The payment will be full compensation for the transportation and installation of all steel poles, mast arms, twin mast arms, triple mast arms, strain poles, pedestal poles, breakaway base support systems and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Concrete foundations will be measured and paid for as specified in 10 14 15.02, Part 4, (Concrete Foundations for Traffic Signals).

34 41 13.20 STEEL SPAN WIRE

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing steel span wire for signal head or sign mountings, interconnect runs or for tethering purposes when specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Span Wire. Steel span wire shall be one-quarter or three-eighths inch (1/4″ or 3/8″) diameter, seven wire strand, galvanized as specified in A 475, Class C.

B. Galvanizing shall conform to A153.

C. Steel messenger rings shall be sized as specified in the Contract Documents and shall be mechanically or hot dip galvanized after fabrication.

PART 3 EXECUTION

A. The span wire shall be attached to poles by wrapping two (2) full turns of the span wire around the pole at the specified height.

B. The free end of the wrapped span wire shall be two feet (2′) in length and shall be secured to the traversing span wire by a three (3) bolt clamp and serving sleeve as specified in the Contract Documents.

C. All messenger rings shall be spaced 8 inches apart.

PART 4 MEASUREMENT AND PAYMENT

Steel Span Wire of the size specified in the Contract Documents will be measured and paid for at the Contract Unit Price per linear foot for the wire installed. The payment will be full compensation for all hardware, material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 41 13.30 SIGNAL HEADS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing vehicle traffic control signal heads and pedestrian traffic control signal indications and mounting hardware as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Traffic Signal Heads shall conform to the following:

1. Pedestrian signal indications and vehicular signal heads shall conform to the latest revision of the Institute of Transportation Engineers (ITE) Specifications.

a. All materials shall be clean, smooth and free from flaws, cracks, blowholes and other imperfections.

b. Signal heads shall be furnished with the section assembled together including all hardware as specified in the Contract Documents.
c. All metallic signal head hardware shall be stainless steel material.
d. Vehicular, optically-programmed and pedestrian signal heads shall be capable of mating to the same type of the signal heads from either the top or bottom of each housing.
e. All hardware furnished shall be installed on the corresponding fitting and threaded component.

2. Mounting hardware shall conform to the following:

TABLE "A"

ITEM	DESCRIPTION	A	B	C	D
1	Aluminum Alloy—Casting	A 319	A 380	A 713	6063 T6
2	Yield Strength, ksi	18	23	25	25
3	Tensile Strength, ksi	27	47	35	30
4	Brinell Hardness	70	80	75	73
5	Elongation (% in 2 in.)	1.5	4	3	12
6	Stainless Steel	A 316	-	-	-
7	Galvanized Steel	A 157	A 153	G 60	-
8	Steel-Flat Sheet	16 gauge	-	-	-
9	Coating	*	Anodized Finish	-	-

* The signal head housing shall be yellow in conformance with Federal Standards 595, Color Chip No. 13538. The signal head door and visor shall be optical flat (dull) black Federal Standards 595, Color Chip No. 37038. Aluminum signal heads shall be painted using fusion bonded polyester coating method.

3. Hardware. The following materials refer to the items as listed in above Table "A".

a. Hub plate shall conform to A, 1 thru 5 and 9B.
b. Span wire hanger clamp shall conform to C, 1 thru 5.
c. Balance adjuster shall conform to 6A, 7A, and 7B.
d. Two-way lower arm shall conform to 7C and 8A.
e. Two-way tri-stud arm shall conform to A, 1 thru 5.
f. Span wire entrance fitting shall conform to C, 1 thru 5.
g. Mast arm mount signal bracket (1-way, 2-way, and 5-section) shall conform to 1A and 1D.
h. Side pole upper and lower arm assembly shall conform to 1B thru 5B or 1D thru 5D.

4. Vehicular Signal Heads and Pedestrian Signal Indications Housings and Doors.

a. Aluminum signal head housings and doors shall be die-cast aluminum as specified in the Institute of Transportation Engineers Vehicle Traffic Control Signal Head Specification.
b. Dual hinge-latch mechanisms shall be mounted on the signal head housing and not the signal head door. Captive door latch mechanisms (one (1) for eight inch (8″) and two (2) for twelve inch (12″) vehicular signal heads, and

one (1) for nine inch (9″) and two (2) for twelve (12) pedestrian signal indications) shall secure the door to the housing by use of stainless steel eyebolts and wing nut assemblies.

c. All openings to the housing interior shall be provided with a gasket conforming to the physical properties listing in UL 508 and that forms a weather tight seal.

5. Visors.

a. Visors shall be as specified in the Institute of Transportation Engineers Vehicle Traffic Control Signal Head Specification and shall be tunnel type. Visors shall be ten inches (10″) deep for twelve inch (12″) vehicular signal heads, eight inches (8″) deep for eight inch (8″) vehicular signal heads, nine inches (9″) deep for twelve inch (12″) pedestrian signal indications, and nine and one-half inches (9-1/2″) deep for optically programmed signal heads.

b. Visors shall be secured to the signal head door by a minimum of (4) screws mounted perpendicular to the face of the signal head door. Visors for aluminum vehicular signal and pedestrian signal sections shall be made from aluminum alloy sheet. Visors for polycarbonate signal sections shall be either formed from sheet plastic or assembled from one (1) or more injection, rotational or blow-molded polycarbonate sections.

6. Optical System. Optical system for vehicular and pedestrian traffic control signal indications shall conform to the following.

a. Signal Head Lamps. Signal head lamps shall be approved by the City.

b. Reflector. Reflector shall be made of aluminum.

c. Reflector support assembly shall be die cast aluminum, separate from the reflector and fully encompass the periphery of the reflector.

d. Reflector support assembly shall be spring hinged to allow access to the rear of the signal head main body without the use of tools.

e. Lens. Lens shall be standard (ball) red, yellow or green, or specified arrow red, yellow, or green traffic signal lens. The lens shall be glass. Directional arrow lenses shall have the same brilliance, regardless which direction they are positioned in the signal face. The lens shall fit into a one (1) piece slotted neoprene lens gasket designed to provide a weather resistant fit to the housing door. Lenses shall be secured by a flat clip/screw design fastened from the inside of the signal head door perpendicular to the face of the door. The flat clip/screw design shall not pass through the lens itself. All pedestrian signal heads shall provide the messages of “walk” and “don’t walk” in the international walking person and the raised hand symbols.

7. Optical System for Optically Programmed Signal Heads.

a. The indication from the lens shall conform to the requirements of ITE transmittance and chromaticity standards.

b. Optically programmed signal heads shall have an optical system containing a color filter, lamp fixture, lamp collar, optical limiter/diffuser and objective lens.

c. Lamp fixtures shall be comprised of a separately accessible housing and integral lamp support, indexed ceramic socket and self-aligning and quick release lamp retainer. Electrical connection between case and lamphousing shall be accomplished with an interlock assembly that disconnects the lamp holder when opened.

d. The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects nine hundred to twelve hundred feet (900′ to 1200′) distance and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be composed of heat-resistant glass.

e. Optically programmed signal heads shall utilize incandescent PAR type lamps. The lamp shall be coupled to the diffusing element. The diffusing element may be discrete or integral with the convex surface of the optical limiter.

f. The objective lens shall be a high resolution annular incremental lens hermetically sealed within a flat laminate of weather resistant acrylic or as approved by the Engineer. The lens shall be symmetrical in outline and may be rotated to any ninety degrees (90°) orientation about its axis without displacing the primary image.

8. Electrical.

a. The entire signal head assembly shall be either listed or labeled by a Maryland State Fire Marshall or a recognized electrical inspection agency.

b. Wiring connections at the lamp socket shall lock and not be of the male/female demountable type.

c. A unitized bail wire with integral spring shall secure the socket to the rear of the reflector. The lamp socket shall have a serrated base to permit locking.

d. Each single section and the middle section of three (3) section signal heads shall have a minimum of a six (6) section, twelve (12) position terminal block capable of accepting three (3) number 14 AWG spade terminal ends. The top section of two (2) section pedestrian signal indications shall be furnished with a minimum of five (5) sections, ten (10) position terminal blocks capable of accepting three (3) number 14 AWG spade terminal ends.

e. Optically programmed signal heads shall not contain a resistance device for use as an intensity controller with integral means for regulating its intensity between limits as a function of individual background illumination.

PART 3 EXECUTION

Aiming: Signal heads shall be aimed to be visible in conformance with the minimum requirements of the MUTCD.

PART 4 MEASUREMENT AND PAYMENT

Aluminum, Polycarbonate and Optically Programmed Signal Heads and Pedestrian Signal Indications furnished and installed will be measured and paid for at the Contract Unit Price per each section of signal head type and size as specified in the Contract Documents. The payment will be full compensation for all lenses, mounting hardware, assembly and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 41 16.06 TRENCHING AND BACKFILLING FOR TRAFFIC CONTROL DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of excavating and backfilling trenches to the width required to receive underground conduit, wire or duct cable for traffic control devices as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Backfill. The lower one foot (1′) depth of trench shall be fine aggregate conforming to 31 62 13.21, Part 2.1, A, (Protective Jackets for Piles). Material above the one foot (1′) depth shall be select material conforming to 32 16 13.13, Part 2.1, K, (Cast-in-Place Curbs and Gutter).

B. Conduit Detection Tape. Electrical conduit detector tape shall consist of one (1) layer of aluminum foil laminated between two (2) layers of inert plastic film. The foil shall be three inches (3″) wide with a tensile strength of sixty (60) pounds. The plastic film shall have a minimum thickness of four and one-half (4.5) mil.

PART 3 EXECUTION

A. Trenches shall be excavated to the dimensions and lines specified and shall conform to 31 23 16.16, (Structure Excavation).

B. In areas where conduit is trenched, a detector tape shall be placed in the trench at a depth of six inches (6″) below the finished grade. The color of the tape shall be red. The tape shall be imprinted with a continuous warning message that reads “CAUTION: CITY ELECTRICAL LINE BURIED BELOW”, repeated every thirty-six inches (36″). The tape shall be inductively and conductively traceable using a standard pipe and cable locating device.

C. Cable Treatment. The duct cable and direct buried wires shall be bedded into the special backfill material as specified in the Contract Documents.

D. Backfill. The trench shall be backfilled and compacted as specified in 34 41 16.06, (Trenching and Backfilling for Traffic Control Devices), and restored to its original condition, including replacing topsoil, reseeding, and resodding as directed by the Engineer.

E. All excess or unsuitable material shall be disposed of as specified in 31 23 16.16, (Structure Excavation).

PART 4 MEASUREMENT AND PAYMENT

Trenching and backfilling will not be measured but the cost will be incidental to the Contract Unit Price for the installation of the pertinent conduit, detector tape, wire, or duct cable.

34 41 16.08 TRAFFIC CONTROL DEVICE CABINETS AND EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of installing City furnished traffic signal controllers and cabinets, furnishing and installing traffic signal controllers and cabinets, and furnishing and installing lighting control cabinets for highway and sign lighting as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Conduit shall conform to 26 07 01.01, (Electrical Conduit and Fittings).

B. Control and Distribution Equipment shall conform to 26 27 01, (Electrical Service Equipment).

C. Anchor Bolts, Hardware, Cabinets and Controllers shall be furnished by, or as approved by the City.

PART 3 EXECUTION

3.1 BASE MOUNTED TRAFFIC SIGNAL CABINETS

Base mounted cabinets shall be mounted on concrete foundations conforming to 10 14 15.02, (Concrete Foundations for Traffic Signals), and as specified in the Contract Documents. Conduit shall be furnished and installed as specified in 26 07 01.01, (Electrical Conduit and Fittings).

3.2 POLE MOUNTED TRAFFIC SIGNAL CABINETS

Pole mounted cabinets shall be installed as specified in the Contract Documents. Conduit shall be furnished and installed as specified in 26 07 01.01, (Electrical Conduit and Fittings).

3.3 BASE MOUNTED LIGHTING CABINETS

Where base mounted lighting cabinets are specified, the Contractor shall furnish and install an equipment enclosure, panel boards, transformers, circuit breakers, lighting contactor, relay, photoelectric controls, thermostats, selector switches, fans, lightning arresters, conduit, wiring and wiring devices, ground fault interrupters, and all other equipment necessary to provide a complete functioning lighting cabinet as specified in the Contract Documents. All electrical outlets shall be protected by ground fault interrupters (GFI).

3.4 POLE MOUNTED LIGHTING CABINETS

Where pole mounted lighting cabinets are specified, the Contractor shall furnish and install a NEMA 4X, stainless enclosure with attachment hardware for attaching the unit to a utility pole, wood post or traffic control device structure. Included electrical equipment shall be a sixty (60) amp, two (2) pole main circuit breaker; a sixty (60) amp, two (2) pole electrically

held lighting contactor; four (4), two (2) pole circuit breakers at the amperage specified in the Contract Documents; photoelectric control; lightning arrester; and all incidentals necessary to provide a complete lighting control unit.

PART 4 MEASUREMENT AND PAYMENT

A. Installing City furnished signal controllers and cabinets or furnishing and installing Contractor furnished traffic signal controllers and cabinets will be measured and paid for at the Contract Unit Price per each for the pertinent item. The payment will be full compensation for furnishing the controller or cabinet when specified, installation, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Concrete foundations will be measured and paid for as specified in 10 14 15.02, Part 4, (Concrete Foundations for Traffic Signals).

C. Conduit will be measured and paid for as specified in 26 07 01.01, Part 4, (Electrical Conduit and Fittings).

D. Ground rods will be measured and paid for as specified in 26 44 00, Part 4, (Grounding).

E. Lighting Cabinets will be measured and paid for at the Contract Unit Price per each of the type and size as specified in the Contract Documents. The payment will be full compensation for all enclosures, panel boards, transformers, circuit breakers, contactors, relays, photoelectric controls, thermostats, fans, selector switches, ground fault interrupters, lightning arresters, conduit, internal wiring, wiring devices, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 41 16.09 PUSH BUTTONS AND PUSH BUTTON SIGNS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing round pedestrian push button assembly with two inch (2″) plunger and push button signs at locations specified in the Contract Documents, or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Retroreflective Sheeting (Type II). When specified in the Contract Documents, engineering grade retroreflective sheeting shall conform to D 4956, Type II.

B. Push Button Sign. The manufacturer or supplier shall furnish certification for the following items:

1. Sheet Aluminum Sign Panels. Sign panels shall conform to B 209, with an anodized mill finish. Alloys shall be either 6061 T6 or 5052-H38.
2. Extruded Aluminum Sign Panels and Edge Strip. Extruded aluminum sign panels and edge strip shall conform to B 221, alloy 6063 T6.

3. Hardware. Hardware shall be clear anodized, conforming to one of the following: B 209, alloy 2024 T4; B 211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6 or 2017 T4.

C. Certification shall verify that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor"s/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer.

D. Push Buttons shall conform to A 319. The push button assembly shall be weather-tight and tamper proof. The assembly shall be designed to prevent an electrical shock under any weather condition and shall have provisions for grounding in conformance with the NEC.

1. The push button assembly shall be fabricated from aluminum ingot and have an anodized finish.
2. The push button plunger shall be chrome plated, two inches (2") diameter and have a spring with operative force not to exceed five (5) lb.
3. The push button switch shall have single-pole momentary, normally open, single-throw contacts and spade-type terminals.
4. The switch assembly shall have an operating force of approximately five-tenths (0.5) lb, but shall not exceed one (1) lb.
5. The switch assembly shall be UL approved and electrically rated to carry twenty-five (25) amps at one-hundred twenty (120) volts AC.

PART 3 EXECUTION

A. Push buttons shall be located as specified in the Contract Documents in positions that clearly indicate to the pedestrian which crosswalks are actuated by each push button.

B. The Contractor shall furnish all mounting hardware and drill holes to provide cable and wire entrances as specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

Push buttons and push button signs will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for furnishing, installing, drilling of holes, mounting hardware, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 71 00 ROADWAY CONSTRUCTION

34 71 13.01 TEMPORARY TRAFFIC BARRIER END TREATMENTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, erecting, maintaining, resetting and removal of temporary traffic barrier end treatments in conformance with the manufacturer's recommendations or as directed by the Engineer. The traffic barrier end treatments shall be located as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Temporary traffic barrier end treatments shall conform to the Contract Documents or City's approved list.

B. Temporary crash cushion sand filled plastic barrels (SFPB) shall conform to 34 71 13.17, (Temporary Crash Cushion Sand filled Plastic Barriers (SFPB)).

PART 3 EXECUTION

3.1 TEMPORARY END TREATMENTS

A. Temporary Type E and J traffic barrier end treatments shall be installed in conformance with the manufacturer's recommendations and as approved by the Engineer. The nose section on the traffic barrier end treatment shall be reflectorized as approved by the Engineer or the Department of Transportation.

B. SFPB shall be installed in conformance with to 34 71 13.17, Part 3, (Temporary Crash Cushion Sand filled Plastic Barriers (SFPB)).

3.2 INSPECTION OF END TREATMENTS

A. Daily visual inspections of the devices shall be performed in conformance with the Contract Documents to determine that no undetected damage has occurred and that the end treatment is capable of functioning as intended.

B. Following an impact, an approved reflectorized drum conforming to the Contract Documents will suffice temporarily as reflectorization of the end treatment until the damaged end treatment can be replaced. The damaged end treatment shall be repaired or replaced no later than four (4) hours after the Contractor is notified.

PART 4 MEASUREMENT AND PAYMENT

A. Temporary Traffic Barrier End Treatments: Remove and reset temporary traffic barrier end treatments and repairing temporary traffic barrier end treatments will be measured and paid for at the Contract Unit Price for one or more of the items below unless otherwise specified in the Contract Documents.

1. Temporary traffic barrier End treatments will be measured and paid for at the Contract Unit Price per each for the type specified in the Contract Documents. The payment will be full compensation for all base pads, anchors, fastenings, fixtures, reflectorization, erection of materials, backup blocks, supports, galvanizing of metal parts, connections to bridges, structures or fixed objects and for all material, labor, equipment, tools, and incidentals necessary to provide a complete temporary traffic barrier end treatment.
2. Temporary crash cushion sand filled plastic barrels will be measured and paid for as specified in to 34 71 13.17, Part 4, (Temporary Crash Cushion Sand Filled Plastic Barriers (SFPB)).
3. Remove and reset temporary traffic barrier end treatments will be measured and paid for at the Contract Unit Price per each, for the type specified in the

Contract Documents, removed, relocated and reset in a manner acceptable to the Engineer. The conditions specified for the initial installation and removal of the end treatment shall be applicable to removing and resetting the end treatment.

4. Temporary traffic barrier end treatment spare parts package furnished and installed will be measured and paid for at the Contract Unit Price per each for the type specified in the Contract Documents. The payment will be full compensation for the complete furnishing and installation, complete clearing and removal of debris and damaged unsalvageable parts and for all material, labor, equipment, tools, and incidentals necessary to construct the temporary end treatment to the configuration specified in the traffic control plan or as directed by the Engineer. When spare parts packages are furnished by the City, repairing temporary traffic barrier end treatments will be measured and paid for at the Contract Unit Price per each for the type specified in the Contract Documents. The payment will be full compensation for all transportation, installation, reconnection to fixed objects where necessary, complete clearing and removal of debris and damaged unsalvageable parts and for all material, labor, equipment, tools, and incidentals necessary to construct the temporary end treatment to the configuration specified in the traffic control plan or as directed by the Engineer.
5. Payment will not be made for spare parts packages used for end treatments damaged due to the Contractor's operations as determined by the Engineer.
6. Removal of the temporary traffic barrier end treatments will not be measured but the cost will be incidental to the initial Contract Unit Price per each. Removal shall include patching of any holes made to anchor or stabilize the end treatment and cleaning and clearing the area of all debris.

34 71 13.02 DRUMS FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and placing drums and maintaining in like new condition. The drums shall be located as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Reflectorization shall conform to 10 14 53, (Signs).

B. Plastic drums shall be as approved by the Engineer.

C. Drums shall be manufactured of low-density polyethylene (PE) to withstand impact without damage to themselves or vehicles. The drum shall have a height of thirty-six inches (36″) and a minimum diameter of eighteen inches (18″). Drums may have one (1) or more flat sides as long as the minimum eighteen inches (18″) diameter is satisfied. The reflective stripes shall be horizontal, circumferential, orange and white, six inches (6″) wide, two (2) each of white and orange alternating with the top stripe being orange.

D. Effective January 1, 2006, high performance wide-angle white and fluorescent orange reboundable sheeting shall be used on drums. Prior to January 1, 2006, this sheeting may be used in projects as needed.

PART 3 EXECUTION

A. Drums shall be adequately weighted with bags of sand or sand filled bases to keep them from moving. Sandbags, with no other attachments, shall rest on the base of the drum.

B. The Contractor will be permitted to neatly stencil its name or identification mark at the bottom of the nonreflective portion of the drum in maximum two inch (2") high letters. No other markings or writings will be permitted on the vertical side of the drum.

C. Drums damaged by traffic shall be replaced within four (4) hours after the Contractor is notified.

PART 4 MEASUREMENT AND PAYMENT

A. Drums for maintenance of traffic will be measured and paid for once at the Contract Unit Price per each. The payment will include reflectorization, setting, resetting, removing, sandbags, maintenance, cleaning of drums to like new condition and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Where drums have been set and are subsequently damaged by traffic and the Engineer determines that they are not repairable, they shall be replaced and will be measured and paid for at the Contract Unit Price.

34 71 13.03 BARRICADES FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing barricades for maintenance of traffic. Barricades shall be used as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Reflectorization shall conform to 10 14 53, (Signs).

B. Barricades shall be as approved by the Engineer.

PART 3 EXECUTION

A. All barricade rails shall conform to MUTCD unless otherwise specified in the Contract Documents. The barricade reflective sheeting and its installation shall be as approved by the Engineer.

B. Barricades damaged by traffic shall be replaced within four (4) hours after the Contractor is notified.

PART 4 MEASUREMENT AND PAYMENT

A. Barricades will be measured and paid for at the Contract Unit Price per each for the pertinent barricade item specified in the Contract Documents and accepted by the Engineer. The payment will be full compensation for the installation, maintenance, warning lights, (when required by the traffic control plan), the maintenance and removal of any required warning lights, removal of the barricades, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Where barricades have been set and are subsequently damaged by traffic and the Engineer determines that they are not repairable, they shall be replaced and will be measured and paid for at the Contract Unit Price.

34 71 13.04 CONES FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing new or like new cones in conformance with the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIALS

A. Reflectorization shall conform to 10 14 53, (Signs).

B. Cones shall be as approved by the Engineer.

C. Cones shall have a minimum height of twenty-eight inches (28″), with a minimum circular inside diameter of ten inches (10″) at the base. Cones shall be reflectorized via reflectorized sheeting or collars during periods of darkness and be equipped with cone anchor collars as approved by the Engineer and as needed to maintain an upright position.

PART 3 EXECUTION

A. Cones shall be installed as specified in the Contract Documents or as directed by the Engineer.

B. Cones damaged by traffic shall be replaced within four (4) hours after the Contractor is notified.

PART 4 MEASUREMENT AND PAYMENT

Cones for maintenance of traffic and cones that have to be replaced will not be measured but the cost will be incidental to the Contract Price for maintenance of traffic.

34 71 13.05 PERMANENT TRAFFIC BARRIER END TREATMENTS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing permanent traffic barrier end treatments as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Refer to 34 71 13.25, Part 2, (Metal Traffic Barriers) and the following:

B. End treatments and spare parts packages shall be as specified by the manufacturer.

C. Hazard marker shall be as approved by the Engineer.

D. Plastic barrels shall be as approved by the Engineer.

E. Sand shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

F. Graded Aggregate Base shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

G. Bank Run Gravel Base shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

H. Common Borrow shall conform to 31 23 16.12, Part 2, (Select Borrow Excavation).

I. Topsoil shall conform to 31 14 13.24, Part 2, (Topsoil).

PART 3 EXECUTION

3.1 END TREATMENTS

A. Type A System

1. The Type A Systems (single and double rail) shall have the ends of the traffic barrier, the end anchorage terminal and the rub rail when required, buried in a cut slope. The slope shall be excavated to install these components. Upon installation the area shall be backfilled to match the adjacent slope, compacted, seeded, mulched and soil stabilization matting installed as directed by the Engineer. The single rail system shall use six foot (6′) posts throughout the entire end treatment. The double rail system shall use eight foot (8′) posts throughout the entire end treatment except for the last three (3) posts buried in the cut slope.
2. The Contractor shall select Option 1 or 2 from the standard for constructing the end anchorage terminal.
3. Installation of traffic barrier W beam shall conform to 34 71 13.25, Part 3, (Metal Traffic Barrier).

B. Type B System. This system shall be installed in conformance with the manufacturer's recommendations.

C. Type C, D, E, and F. These systems are not designed to be curved and shall be installed in a straight line unless otherwise specified by the manufacturer and approved by the Engineer. For installation methods and procedures, refer to the manufacturer's recommendations.

D. Nose Section. The nose section on the traffic barrier end treatment shall be reflectorized as approved by the Engineer.

E. Finish Coat. Traffic barrier end treatments attached to W beam traffic barrier shall have the same finish coat. Refer to 34 71 13.25, Part 3, (Metal Traffic Barrier).

F. Sand Filled Plastic Barrels (SFPB).

1. The components, assembly, placing configuration and filling of the individual standard yellow plastic barrels with varying weights of sand shall conform to the manufacturer's recommendations or as specified in the Contract Documents.
2. Each SFPB shall be watertight and separated from all other SFPB by a distance of three inches (3″). The distance between the last row of SFPB and the object being shielded shall be twelve inches (12″).
3. The first barrel of the SFPB configuration shall be reflectorized as specified in the Contract Documents.
4. All sand to be placed in the barrels shall be dry and loose. Bags of sand are prohibited. An antifreeze agent shall be added to the sand in conformance with the manufacturer's recommendations.

3.2 SURFACE ADJUSTMENT

When surface adjustment is required for installation of Type B, C, D, E, and F end treatments as specified on the Standards or in the Contract Documents, the Contractor shall use any class of excavation available on the project. When excavation is not available on the project site, the surface adjustment for end treatments shall be constructed using bank run gravel base, graded aggregate base, common borrow, or topsoil. The surface adjustment shall be completed within forty-eight (48) hours.

3.3 TRANSITIONS TO EXISTING STRUCTURES

When transitions to existing structures or traffic barriers are required, the Work shall be as recommended by the manufacturer of the specified end treatment.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all excavation, fabrication of all component parts, transitions to barriers, reflectorization, backfill, restoration of grassed or paved areas, seed and mulch, soil stabilization matting and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Traffic Barrier End Treatments will be measured and paid for at the Contract Unit Price for the pertinent end treatments below.

C. Removal of the existing end treatment to be replaced will not be measured but the cost will be incidental to the Contract Unit Price for the respective end treatments.

D. Type A Traffic Barrier End Treatments (Single and Double Rail) will be measured and paid for as follows:

1. Traffic Barrier W Beam per linear foot for the actual number of linear feet measured to centers of posts. When a double rail installation is required, each rail will be measured and paid for at the Contract Unit Price per linear foot for traffic barrier W beam.
2. End Anchorage Terminals will be measured and paid for at the Contract Unit Price per each.

E. Type B through J Traffic Barrier End Treatments per each.

F. Surface adjustment for Types B, C, D, E, and F end treatments will be measured and paid for at the Contract Unit Price per cubic yard for the surface adjustment for traffic barrier end treatment item. The payment will be full compensation for furnishing, adjusting embankment or aggregate material, compaction and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

G. Permanent Crash Cushion Sand Filled Plastic Barrels will be measured and paid for at the Contract Unit Price per barrel. The payment will be full compensation for all Furnishing, placing, excavation, sand, antifreeze agent, machinery, labor, equipment, tools, and incidentals necessary to complete the Work.

H. Repairs

1. Traffic Barrier End Treatment Spare Parts Package furnished and installed will be measured and paid for at the Contract Unit Price per each for the type specified in the Contract Documents. The payment will be full compensation for the complete furnishing and installation of the spare parts package, complete clearing and removal of debris and damaged unsalvageable parts and for all material, labor, equipment, tools, and incidentals necessary to construct the end treatment to the configuration specified in the Contract Documents or as directed by the Engineer.
2. When spare parts packages are furnished by the City, repairing traffic barrier end treatments will be measured and paid for at the Contract Unit Price per each for the type specified in the Contract Documents. The payment will be full compensation for all transportation, installation, reconnection to fixed objects where necessary, complete clearing and removal of debris and damaged unsalvageable parts and for all material, labor, equipment, tools, and incidentals necessary to construct the end treatment to the configuration specified in the Contract Documents or as directed by the Engineer.
3. Payment will not be made for spare parts packages used for end treatments damaged due to the Contractor's operations as determined by the Engineer.

I. The application of fusion bonded brown polyester coating, as well as all special handling will not be measured but the cost will be incidental to the item to which the coating is applied.

34 71 13.17 TEMPORARY CRASH CUSHION SAND FILLED PLASTIC BARRELS (SFPB)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing and installing Sand Filled Plastic Barrels (SFPB). Sand Filled Plastic Barrels shall be arranged as specified in the traffic control plan or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sand shall conform to 32 11 23.10, (Aggregate Base Course).

B. Plastic Barrels (Yellow) shall be as approved by the Engineer.

PART 3 EXECUTION

A. The ground shall be leveled with material comparable to the existing ground or as approved by the Engineer to support the system prior to installing the SFPB.

B. The components, assembly, placing configuration and filling of the individual plastic barrels with varying weights of sand shall conform to the manufacturer's recommendations or as specified in the Contract Documents. The barrels shall be watertight. SFPB may be permitted to stand on pallets four inches (4″) high or less.

C. The first barrel of the SFPB configuration shall be reflectorized as specified in the Contract Documents. Following an impact, an approved reflectorized drum, conforming to the Contract Documents, will suffice temporarily as reflectorization of the SFPB until the damaged SFPB can be replaced. The damaged barrels shall be replaced within four (4) hours after the Contractor is notified.

D. All sand to be placed in the barrels shall be dry and loose. Bags of sand are prohibited. The Contractor shall have available sufficient replacement materials including sand. An antifreeze agent shall be added to the sand in conformance with the manufacturer's recommendations.

E. Immediately after the SFPB have served their intended purpose, the Contractor shall remove the installation and restore the site as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Temporary crash cushion sand filled plastic barrels will be measured and paid for at the Contract Unit Price per barrel for one or more of the items below and specified in the Contract Documents.

1. Temporary crash cushion sand filled plastic barrels for maintenance of traffic.
2. Replace temporary crash cushion sand filled plastic barrels for maintenance of Traffic.

3. Remove and reset temporary crash cushion sand filled plastic barrels for maintenance of traffic.

B. The payment will be full compensation for furnishing, excavation, placing, installing, cleaning, maintaining, sand, antifreeze agent, machinery, replacement, remove, reset, re-grading, and removing from the project the individual weighted barrels in a manner acceptable to the Engineer and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

34 71 13.20 TEMPORARY CONCRETE TRAFFIC BARRIER (TCB) FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, placing, resetting, and removing temporary concrete traffic barriers for use at locations specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast Concrete Traffic Barrier. Precast concrete traffic barrier shall conform to the Contract Documents. Welded wire fabric shall conform to M 55.

B. Vertical panels, reflective barrier markers and warning lights shall be approved by the Engineer.

PART 3 EXECUTION

A. The Contractor shall maintain TCB's in alignment and in a like new condition.

B. Resetting TCB's shall consist of removing and relocating TCB's as directed by the Engineer.

C. Items such as reflective barrier markers, vertical panels (object markers) and warning lights shall be installed on the TCB as specified in the Contract Documents.

D. The precast temporary thirty-two inch (32″) F shape concrete traffic barrier will be specified in the Contract Documents, however, the Engineer may approve the use of the precast temporary thirty-two inch (32″) Jersey shape concrete traffic barrier Maryland State Highway Administration Standards Nos. MD 104.01-40 and 41 until July 1, 2006, so long as only one (1) type of barrier is used on any particular project.

E. Connections. The TCB joint connections shall be the pin and loop connection as specified in the standards. The channel splice, vertical I beam, and lapped joint connections specified in the AASHTO Roadside Design Guide, the proprietary T-Lok and J-J Hook Systems will be allowed provided only one (1) type of joint connection is used for the length of the barrier.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for furnishing, placing, maintaining and removal from the project site as directed by the Engineer and for all material, labor, equipment, tools and incidentals necessary to complete the Work.

1. Temporary concrete traffic barrier for maintenance of traffic and reset temporary concrete traffic barrier for maintenance of traffic will be measured and paid for at the Contract Unit Price per linear foot measured along the centerline of the top of the barrier.
2. Reflective barrier markers, vertical panels and warning lights will be measured and paid for at the Contract Unit Price per each.
3. The payment to reset the temporary concrete traffic barrier for maintenance of traffic will also include removal from its original placement, transporting and resetting it in its new temporary location and applicable portions of paragraph 4.A.1.

34 71 13.21 TRAFFIC BARRIER W BEAM (TBWB) FOR MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, erecting, maintaining, resetting and removing temporary TBWB at locations specified in the traffic control plan or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Traffic Barrier W Beam. Refer to 34 71 13.25, Part 2, (Metal Traffic Barriers).

B. Traffic Barrier Posts. Refer to 34 71 13.25, Part 2, (Metal Traffic Barriers).

C. Hardware for Traffic Barriers. Refer to 34 71 13.25, Part 2, (Metal Traffic Barriers).

D. Wood Offset Blocks. Refer to 34 71 13.25, Part 2, (Metal Traffic Barriers).

PART 3 EXECUTION

3.1 TBWB Construction methods shall conform to the applicable portions of 34 71 13.25, (Metal Traffic Barriers).

3.2 TBWB REPLACEMENT

Any portion of the TBWB that is damaged shall be replaced immediately. This Work shall be accomplished utilizing the Contract item TBWB for maintenance of traffic replacement. The TBWB shall be installed to the correct horizontal and vertical alignments. The offset blocks shall be of the same kind.

3.3 TBWB RESET

A. When Work is sufficiently completed through a traffic control area and TBWB is no longer required, the TBWB and all components shall be removed and reset in a new Work area as specified in the Contract Documents or as directed by the Engineer. The area shall be restored to its original condition.

B. TBWB end treatment shall conform to 34 71 13.01, (Temporary Traffic Barrier End Treatments) and 34 71 13.17, (Temporary Crash Cushion Sand Filled Plastic Barrels (SFPB)).

C. All ends of TBWB shall have an approved end treatment placed prior to opening to traffic.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for furnishing and installing all cables, posts, brackets, traffic barrier W beam, hardware, galvanizing, excavation, backfilling, connections to rigid structures, removal, restoration of the area and for all material, labor, equipment, tools, and incidentals necessary to complete the Work as directed by the Engineer.

1. Traffic Barrier W Beam for Maintenance of Traffic will be measured and paid for at the Contract Unit Price per linear foot.
2. Replacing sections of the traffic barrier that have been damaged by vehicular traffic while in place will be measured and paid for at the Contract Unit Price per linear foot for the traffic barrier W beam replacement for maintenance of traffic item.
3. Reset traffic barrier W beam for maintenance of traffic will be measured and paid for at the Contract Unit Price per linear foot.

34 71 13.22 TUBULAR MARKERS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, installing and removing tubular markers for maintenance of traffic as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Tubular markers shall be as approved by the Engineer.

B. Reflectorization shall conform to 10 14 53, (Signs).

PART 3 EXECUTION

Tubular markers shall be installed as recommended by the manufacturer and as approved by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

A. Tubular markers will be measured and paid for at the Contract Unit Price per each. The payment will be full compensation for the removal of and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Tubular markers that are damaged as a result of traffic operations shall be replaced and will be measured and paid for at the Contract Unit Price per each for replacement of tubular marker mast. If the base detaches from the pavement, the entire tubular marker assembly shall be replaced by the Contractor at no additional cost to the City, unless damaged by City snow removal operation.

34 71 13.23 TEMPORARY MOVABLE TYPE CONCRETE TRAFFIC BARRIER (MCTB)

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of furnishing, placing, assembling, maintaining, moving, removing and disposing of a movable interlocking type concrete traffic barrier where specified in the Contract Documents or as directed by the Engineer. Movable barrier systems shall consist of individual units that remain connected for the total length when being moved in one (1) continuous operation at a minimum speed of three (3) mph and a minimum lane shift of twelve feet (12'). The transfer device shall be capable of operating on the curve and grades as indicated in the Contract Documents.

PART 2 PRODUCTS

2.1 MATERIAL

A. Precast movable concrete barrier and transfer device shall be as specified by the manufacturer.

B. Reflective barrier markers shall be as approved by the Engineer.

PART 3 EXECUTION

A. The transfer device shall have the capability to move or transfer the barrier as specified in the Contract Documents. The device is prohibited from extending into oncoming traffic lanes from either direction during lane shifts.

B. The Engineer will inspect the movable barrier upon delivery and throughout the life of the project. Any units deemed damaged or defective in the concrete or joint connections affecting the performance of the barrier systems shall be replaced. Reflective barrier markers shall be as specified in the Contract Documents. The barrier and reflective barrier markers shall be maintained in a like new condition.

C. The Contractor shall perform all maintenance operations for the transfer device and shall have sufficient spare parts and personnel available to ensure that the required lane configurations are maintained at the required times. Failure to move the MCTB at the proper time will be cause for a penalty.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the Work.

1. The initial installation of the temporary movable type concrete traffic barrier will be measured and paid for at the Contract Unit Price per linear foot measured in place from end to end. The payment will also include furnishing, placing, maintenance, transfer device and all associated costs, replacing sections damaged during installation and removing the barrier from the project site.
2. Transfer shifts of the barrier will be measured and paid for at the Contract Unit Price per linear foot for the transfer shift of movable type concrete barrier item. The measurement will be end to end for the barrier actually shifted. The Contract Unit Price will apply to each shift. The payment will also include the shift, the transfer device and associated costs.
3. Replacing sections of the barrier, which have been damaged by vehicular traffic while in place, will be measured and paid for at the Contract Unit Price per each for the replacement sections for movable type concrete barrier item. At the direction of the Engineer, sections damaged by the Contractor's operations that require replacement, shall be replaced at no additional cost to the City. The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the Work.
4. Resetting the barrier will be measured and paid for at the Contract Unit Price per linear foot for the reset movable type concrete barrier item. The payment will also include removal from its original placement, transporting and resetting it in its new temporary location.
5. Reflective barrier markers will be measured and paid for as specified in 34 71 13.20, paragraph 4.A.2.
6. When end treatments are required, they will be measured and paid for under the pertinent item specified in the Contract Documents.

34 71 13.24 CONCRETE TRAFFIC BARRIERS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing concrete traffic barriers as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Crusher Run Aggregate CR 6 shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

B. Aggregate Size No. 57 shall conform to 32 11 23.10, Part 2, (Aggregate Base Course).

C. Curing Materials shall conform to 03 30 00, Part 2, (Portland Concrete Utility Structures).

D. Form Release Compound shall conform to 03 30 00, Part 2, (Portland Concrete Utility Structures).

E. Concrete Mix No. 2 shall conform to 03 30 00, Part 2, (Portland Concrete Utility Structures).

F. Concrete Mix No. 6 shall conform to 03 30 00, Part 2, (Portland Concrete Utility Structures).

G. PVC Pipe shall conform to 33 41 00, Part 2, (Storm Water Drains and Sanitary Sewers).

H. Reinforcement Steel shall conform to 32 13 13.33, Part 2, (Plain and Reinforced Portland Cement Pavement).

I. Preformed Joint Fillers shall conform to 03 30 00, Part 2, (Portland Concrete Utility Structures).

J. Borrow Excavation shall conform to 31 23 16.12, Part 2, (Select Borrow Excavation).

K. Geotextile shall conform to 33 46 16.19, Part 2, (Pipe Underdrains and Outlets).

L. Reflective Delineators shall be as approved by the Engineer.

M. All concrete traffic barriers, end transitions and footers shall be constructed using concrete mix No. 6 unless otherwise specified in the Contract Documents. Before beginning Work the Contractor shall construct a sample panel approximately two feet by two feet by three inches (2' X 2' X 3") using the proposed concrete mix design. After twenty-eight (28) days, the concrete shall match federal standards. The Contractor shall submit the panel and mix design to the Engineer for approval. The approved sample panel shall remain at the Construction site to be used by the Engineer to compare the color of the concrete barrier to the sample panel for adjustments and approval.

N. A sample panel for each source of supply shall be submitted for approval prior to use.

PART 3 EXECUTION

3.1 GENERAL

Concrete barriers shall be cast-in-place. Excavation for concrete barriers shall be made to the required depth and to a width that will permit the installation and bracing of forms where necessary. The Contractor shall remove all soft and unsuitable material and replace it with suitable material as directed by the Engineer. The subgrade shall be properly shaped and compacted in conformance with 31 23 13, (Subgrade Preparation).

3.2 CONCRETE BARRIERS

A. Forming for the footer or concrete barrier may be either the fixed form or the slip-form method. Constructing the footer and the barrier section monolithically is prohibited.

1. Fixed Form Method. Forms shall be steel with a tolerance not to exceed one-quarter inch (1/4″) in ten feet (10′) in either grade or alignment. For bifurcated and transition sections, other forming materials may be used as directed by the Engineer. Before concrete is placed against the forms, they shall be thoroughly cleaned and coated with form release compound each time they are used.

Concrete mixing shall conform to 03 30 43, Part 3, (Production Plants) and placing to 03 30 00, Part 3, (Portland Concrete Utility Structures). Volumetric batching and continuous mixing will be permitted. Concrete shall be vibrated by means of an approved immersion type mechanical vibrator. Construction or contraction joints shall be sawed or formed at twenty foot (20′) intervals with a minimum of ten feet (10′). The time of sawing shall be as specified in 32 13 13.33, Part 3, (Plain and Reinforced Portland Cement Concrete Pavements). Expansion joints shall be placed where specified in the Contract Documents or as directed by the Engineer. All joints in footers and walls shall align.

a. Concrete finishing shall conform to paragraph 3.4 except that the surface shall be broom finished when forms are stripped in less than twenty-four (24) hours. Face forms shall be removed for finishing as soon as the concrete can retain its shape.
b. All honeycombed and damaged areas shall be repaired immediately after the removal of the forms in a manner acceptable to the Engineer.

2. Slip-form Method. Slip-form equipment shall be approved by the Engineer and include the incorporation of automatic guidance controls to follow the line and grade references. On vertical and horizontal curves, an additional intermediate support shall be set in the field to establish a reference line acceptable to the Engineer. The use of ski or shoe sensors reflecting variations in the grade of the existing roadway surface is prohibited.
3. Concrete mixing shall conform to 03 30 43, Part 3, (Production Plants). The consistency of the concrete shall be so that after extrusion it shall maintain the shape of the barrier without support. Slip form equipment shall include internal vibrating capability. The surface shall be free of surface pits larger than three-sixteenths of an inch (3/16″) diameter. The concrete shall require no further finishing other than broomed finish. Whenever a tear occurs during the operation of the slip-form equipment, it shall be repaired immediately or removed and replaced as directed by the Engineer. Construction or contraction joints shall be sawed or formed at twenty foot (20′) intervals in the barrier and footer with a minimum of ten feet (10′), except in the area of miscellaneous structures six feet (6′) will be permitted. Sawed joints shall be a minimum of two inches (2″) deep and one-eighth inch (1/8″) wide. Expansion joints shall be as specified in the Contract Documents or as directed by the Engineer.

3.3 CURING

Concrete curing and protection shall conform to 03 30 00, Part 3, (Portland Concrete Utility Structures).

3.4 FINISHED SURFACE

Finishing concrete shall conform to 03 30 00, Part 3, (Portland Concrete Utility Structures). The completed barrier shall be within one-quarter inch (1/4″) inch in ten feet (10′) from the horizontal and vertical lines specified in the Contract Documents or as approved by the Engineer. It shall present a smooth, uniform appearance.

3.5 REFLECTIVE DELINEATORS

Reflective delineators shall be installed on the concrete traffic barrier as specified in the Contract Documents.

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all concrete, test panels, excavation, removal of existing hot mix asphalt, disposal of excess or unsuitable material, concrete footer, forms, reinforcement, drilled holes, drainage appurtenances, geotextile, No. 57 aggregate, conduit, boxes and fittings, backfilling, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. The removal and disposal of unsuitable material will be measured and paid for at the Contract Unit Price for Class 2 Excavation, which price shall include the cost of using suitable excavation as replacement material. When borrow or selected backfill is authorized as replacement material, payment will be made at the Contract Unit Price for the respective items.

C. Removal of existing concrete traffic barriers will not be measured unless specified elsewhere in the Contract Documents.

D. Concrete traffic barriers will be measured and paid for at the Contract Unit Price per linear foot. Measurement will be along the centerline of the top of the barrier.

E. Concrete traffic barrier end transitions will be measured and paid for at the Contract Unit Price per each.

F. Reflective delineators will be measured and paid for at the Contract Unit Price per each.

34 71 13.25 METAL TRAFFIC BARRIERS

PART 1 GENERAL

1.1 DESCRIPTION

This Work shall consist of constructing metal traffic barriers as specified in the Contract Documents or as directed by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Mix No. 2 shall conform to 03 30 00, Part 2, (Portland Cement Concrete Structures).

B. Brown polyester coating shall conform to the following:

C. W Beam. Rail elements and end treatments shall conform to M 180, Type II or IV. In lieu of galvanizing, rail elements may be coated with a minimum of five (5) mil dry film thickness of inorganic zinc rich primer conforming to M 300, Type I or IA. Zinc dust shall conform to

D 520, Type II. The primer shall be applied in conformance with 09 97 13.23, (Cleaning and Painting New Structural Steel) after the rail elements are fabricated.

D. Metal Posts. Posts shall conform to M 183 for steel and M 111 for galvanized coating. In lieu of galvanizing, posts may be coated with a minimum of five (5) mil dry film thickness of inorganic zinc rich primer conforming to M 300, Type I or IA. Zinc dust shall conform to D 520, Type II. The primer shall be applied as specified by the manufacturer after the posts are fabricated.

E. Traffic Barrier Hardware. Hardware for traffic barriers shall conform to M 183 for quality of steel and M 232 for galvanized coating.

F. Timber Posts. Timber rail and posts shall conform to M 168.

G. Wood Offset Blocks. Wood offset block shall conform to M 168.

H. Wire Rope. Wire rope shall conform to federal Specifications, Type I, general purpose, Class 2, 6 by 19, improved plow steel, fiber core. The individual wire strands shall have a zinc coating of eight-tenths (0.8) oz/ft^2 when tested as specified in T 65.

I. Rub rail shall conform to A 36, Galvanized, A 123.

J. The beam shall conform to M 180, Class A, Type 2.

K. Reflective delineators shall be as approved by the Engineer.

L. The polyester powder shall be a super durable TGIC (Triglycidyl Isocyanurate) polyester conforming to paragraph 2.1.B.5. The polyester powder shall be selected from the pre-qualified materials list maintained by the City.

M. Material used for the touch up system shall be a two (2) component aliphatic polyurethane finish coat shall have minimum solids of seventy percent (70%) by weight and forty-seven percent (47%) by volume. Drying time will be to touch and hardened and shall be the minimum recommended by the paint manufacturer and color matched for patching the polyester coating used. The coating thickness of the touch up material shall be the same as the thickness of the polyester and can be applied in multiple coats.

N. Cleaning and Coating. Cleaning and coating shall be performed in an environmentally controlled plant that is fully enclosed and approved by the City.

O. All items to be coated shall be free of any oil or grease and shall be abrasive blasted to near white in conformance with SSPC SP-10. Cleaned surfaces shall be protected from high humidity, rainfall and surface moisture and shall not be allowed to flash rust. The blast profile shall be two to three (2 to 3) mil as determined in conformance with D 4417, Method C. The thickness of the cured coating shall be seven (7) mil, plus or minus ($\pm$ 2) mil when measured in conformance with D 1186. The cured coating shall have a pencil hardness of 2H when tested in conformance with D 3363. The color of the coating shall match the federal standard color number specified in the Contract Documents. Using a sixty-seven and one-half (67-1/2) volt wet sponge detector, the polyester coating shall be checked for holidays, pinholes and discontinuities. There shall be no more than one (1) deficiency per five (5) ft^2.

2.2 ACCEPTANCE:

The acceptance of a polyester powder will be based on the quality control test results required on the manufacturer's certification. The coating applicator shall be responsible for reviewing certifications to ensure conformance to paragraph 2.1.B.4. The coating applicator shall also maintain a file of all reviewed certifications.

2.3 CERTIFICATION

A. The polyester powder manufacturer shall furnish production batch certification (A certification is a document which verifies that the material and Work complies with the applicable Specifications and includes the actual test results to confirm the statement. The contents of the certification shall be on the Contractor's/vendor's/manufacturer's letterhead or approved document and shall be duly signed by a company officer) showing conformance to the following:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Infrared Spectrogram	D 2621	Match prequalification sample
Taber Abrasion Resistance, mg loss, max	D 4060	100
Specific Gravity	D 5965 (Method A)	Prequalification sample ± 0.02
Color	E 1331 or E 1338	Match Federal Standard 595 color number specified in Contract Documents

B. Polyester Prequalification Requirements. The following physical tests will only be required to prequalify the polyester and will not be required for certification:

TEST PROPERTY	TEST METHOD	SPECIFICATION LIMITS
Abrasion Resistance	Taber Abraser CS-10, 1000 gm load, 1000 cycles, D 1044	100 mg max weight loss
Adhesion	D 3359, Method A (Bonderite 1000 panel	Rating 5A
Gloss	D 525, 60° initial	30–45 per Federal Standard 595
Hardness	D 3363	Min 2H–No gouge
Impact	D 2794	Pass 80 inch·lb
Salt Spray Resistance	B 117, D 1654 1000 hr (Bonderite 1000 panel)	Table 2, Rating 7
Thickness	G 12	7 ± 2 mils
Color	E 1331 or E 1338	As specified in the Contract Documents from Federal Standard 595 20040
Infrared Spectrogram	Equipment manufacture's procedures	Manufacturer's IR
Weather Resistance	D 4587, test condition D Test shall be conducted with a UVA lamp (340 nm peak) for 1000 hr	50 % min gloss retention
Specific Gravity	D 5965	Manufacturer's result

PART 3 EXECUTION

3.1 POST ERECTION

A. Posts shall be driven unless otherwise permitted by the Engineer. The method of driving shall avoid battering or distorting the posts. Posts not driven shall be set in holes of sufficient diameter to allow tamping of the backfill. Postholes shall be backfilled with materials approved by the Engineer and placed in horizontal layers not to exceed 6 inches (6″) loose depth, then thoroughly compacted. When it is necessary to place posts in existing paving, all loose material shall be removed and the paving replaced. Prior to erection of the rail or cable elements, the post shall be properly aligned and be within a one-quarter inch (1/4″) tolerance of line and grade. Posts shall be plumb.

B. If rock is encountered, Construction shall conform to 32 31 13, Part 3, (Chain Link Fence).

3.2 RAIL ASSEMBLY

Rail elements shall conform to the Contract Documents and be erected in a manner resulting in a smooth, continuous installation with laps in the direction of traffic flow. All bolts shall be drawn tight.

3.3 OFFSET BLOCKS

A. New traffic barrier W beam shall be installed with wood offset blocks. The wood offset blocks shall be routed to prevent the blockouts from rotating.

B. When an existing steel offset bracket is damaged, it shall be replaced with a steel bracket.

3.4 CONCRETE CURING

Concrete curing and protection shall conform to 03 30 00, Part 3, (Cast-in-Place Concrete).

3.5 BROWN POLYESTER COATED TRAFFIC BARRIER

A. All components shall be padded and handled with nylon slings during loading, unloading and installation.

B. The Contractor shall preserve the integrity of the polyester coating. If the polyester coating is chipped, scratched, blistered or otherwise separated from the base metal, the Contractor shall repair the damaged areas using the repair kit supplied by the manufacturer. All repairs shall be completed to the satisfaction of the Engineer or be replaced at no additional cost to the City.

3.6 REFLECTIVE DELINEATORS

Reflective delineators shall be installed on the traffic barrier W beam as specified in the Contract Documents.

3.7 REMOVE AND RESET EXISTING TRAFFIC BARRIER

When the entire run of traffic barrier is removed and reset, the metal offset brackets shall be replaced with eight inch (8″) wood offset blocks. When only a portion of a run is removed

and reset, the metal offset brackets shall be replaced with six inch (6″) wood blocks. The wood block shall match the existing postholes. The posts shall be moved a minimum of one foot (1′) in either direction from the existing location. When resetting the rail, the height of the rail shall be measured to ensure it conforms to the current Standards. The offset distance from the edge of the roadway shall be maintained unless otherwise directed by the Engineer.

3.8 END TREATMENTS

Refer to 34 71 13.05, (Permanent Traffic Barrier End Treatments).

PART 4 MEASUREMENT AND PAYMENT

A. The payment will be full compensation for all rock excavation, components, restoration of grassed or paved areas, drilled post holes, concrete, assembly and erection of all component parts, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

B. Traffic barrier W beam will be measured and paid for at the Contract Unit Price per linear foot. The beam traffic barrier will be measured and paid for as specified in the Contract Documents. The application of fusion bonded brown polyester coating, as well as all special handling and touch up, will not be measured but the cost will be incidental to the item to which the coating is applied.

C. Replacing and installing additional posts, splice joints and W beam panels will be measured and paid for at the pertinent Contract Unit Price.

D. Removal and disposal of existing traffic barrier will be measured and paid for at the Contract Unit Price per linear foot.

E. Remove and reset existing traffic barrier will be measured and paid for at the Contract Unit Price per linear foot. Wood offset blocks will not be measured, but the cost will be incidental to the item.

F. Reflective delineators will be measured and paid for at the Contract Unit Price per each.

34 71 17 TRUCK MOUNTED ATTENUATOR (TMA)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work shall consist of furnishing Truck Mounted Attenuators as specified in the Contract Documents or as directed by the Engineer.

B. The Truck Mounted Attenuators shall consist of an impact attenuator, a support truck and support structure designed for attaching the system to the support truck. The truck size and the method of attachment shall be as specified in the truck mounted attenuator manufacturer's Specifications.

C. The truck mounted attenuator shall be designed to easily attach and detach from the support truck, with the major subassemblies remaining together when detached from the truck.

D. The truck mounted attenuator shall have hand crank jacks with swivel casters for removing the unit from the truck. Removing the jacks when the truck mounted attenuator is in use is not necessary.

PART 2 PRODUCTS

2.1 MATERIAL

Not applicable.

PART 3 EXECUTION

3.1 GENERAL

A. All exposed steel on the attenuator shall be primed and painted yellow. The undercarriage and support frame may be primed and painted black. All welding shall be done by or under the direct supervision of a certified welder.

B. The standard rear-facing surface of the truck mounted attenuator shall have an inverted "V" chevron pattern formed of alternating four inch (4″) wide black and yellow stripes. The sides of the truck mounted attenuator's shall be bordered by a four inch (4″) red and white reflective tape as shown in Maryland State Highway Administration Standard No. MD-104.01-18.

3.2 IMPACT PERFORMANCE

The truck mounted attenuator shall meet all requirements of NCHRP 350 tests fifty and fifty-one (50 and 51) at test level three (3). No part of the truck mounted attenuator shall be designed to intrude under the support vehicle during impact or require a safety clearance under the support vehicle which extends forward of the rear axle.

3.3 DIMENSIONS

A. The truck mounted attenuator shall have a minimum width of ninety-three inches (93″).

B. Road clearance shall be twelve inches (12″) plus or minus one inch (± 1″).

C. Total weight of the truck mounted attenuator shall not exceed 2000 lb.

D. The truck mounted attenuator shall have a standard trailer lighting system, including brake lights, tail lights, turn signals, and ICC bar lights. All wiring shall be protected and adequately supported.

E. When in the vertical position, the truck mounted attenuator shall not require more than thirteen and one-half foot (13.5′) overhead clearance.

3.4 DURABILITY

A. The truck mounted attenuator shall be tested by the manufacturer to insure that travel vibration, in either a vertical or horizontal position, will not affect the performance of the

truck mounted attenuator. Two (2) vibration tests shall be performed. Each test shall be at least forty (40) hours duration. The vibration shall be between five to eight (5 to 8) cycles per second with amplitude of six-tenths (0.60) plus or minus five-hundredths of an inch (± 0.05″) peak to peak. No dampeners or supports shall be used which are not normally used by the truck mounted attenuator and which was not part of the truck mounted attenuator as tested for NCHRP 350.

1. Test one (1) shall be performed with the truck mounted attenuator at a normal operating position.
2. Test two (2) shall be performed to the same truck mounted attenuator at a fully raised travel position.
3. All parts of the truck mounted attenuator shall be measured before test one (1), between the tests, and at the conclusion of test two (2). The truck mounted attenuator shall have failed if:

    a. Any dimension of any part changes more than five-tenths of an inch (0.5″).
    b. There is any damage to the truck mounted attenuator which would impair its ability to function.
    c. Any part becomes detached.

B. The truck mounted attenuator shall be adequately tested to insure that moisture from rain will not impede the energy absorption properties or add significantly to the weight of the truck mounted attenuator.

3.5 TILTING

A. An electrically powered tilt system shall be provided to facilitate the tilting of the truck mounted attenuator cartridge to a ninety degree (90) position from horizontal. The unit shall have a locking device to secure the truck mounted attenuator system in the vertical position. The completed tilt system shall be factory assembled.

B. Both “UP” and “DOWN” operation of the tilting system shall be actuated from both the cab of the truck and by a hand held control switch at the end of a minimum six foot (6′) long cord near the right rear corner of the truck.

C. The operator shall be capable of partially raising the truck mounted attenuator for additional ground clearance when traversing rough terrain and lowering it to the operating position without leaving the truck.

PART 4 MEASUREMENT AND PAYMENT

Truck mounted attenuator will be measured and paid for at the Contract Price per unit day. A unit day shall consist of any approved usage within a twenty-four (24) hour Calendar Day period. If a truck mounted attenuator is used for part of a day, it will be measured as a unit day, regardless of how many times it is relocated. The payment will be full compensation for the complete truck mounted attenuator, licensed truck operator, connecting and disconnecting the attenuator to the truck, transporting and relocating the truck mounted attenuator, and for all material, labor, equipment, tools, and incidentals necessary to complete the Work.

DIVISION 35
WATERWAY AND MARINE CONSTRUCTION

35 20 00 WATERWAY AND MARINE CONSTRUCTION AND EQUIPMENT

35 20 23 DREDGING

PART 1 GENERAL

1.1 DESCRIPTION

This item comprises subaqueous excavation by means of hydraulic or bucket dredging and includes the transporting and disposing of the dredged materials or its use in the project when so stated in the proposal. Also refer to 31 23 23.24, (Hydraulic Fill).

PART 2 PRODUCTS

2.1 MATERIALS

Not applicable.

PART 3 EXECUTION

A. Before proceeding with any dredging operations, the Contractor shall obtain all necessary permits for removal and disposal of dredged material from agencies of the U.S. Government, the State of Maryland and any local authorities having jurisdiction. The Work shall be conducted in full conformity with all Federal, State and local laws and regulations of the Plans and Specifications.

B. Dredging shall be to the lines, grades and cross sections shown on the plans or described in the Special Provisions. The Engineer will check the setting and alignment of the targets, range poles, tide gauges, etc., necessary for the proper control of the Work but these items shall be furnished, set and maintained by the Contractor and it shall provide and maintain proper illumination for them when necessary for night work or for the protection of navigation. Slopes may be bench cut instead of sloped, if preferred, but the full minimum cross section must be maintained and excess material dredged. Dredged material is unclassified and all materials and obstructions encountered within the prescribed limits shall be removed and disposed of as directed by the Engineer. The Engineer may require that dredged areas be swept over with a long straight edge drag in order to detect the presence of materials or obstructions projecting into the cut section and all such materials or obstructions shall be removed. When so specified, dredged materials shall be reserved for use on the project.

C. Dredged material not reserved for use shall be wasted in approved spoil areas whose location and manner of use shall be acceptable to the Federal, State and local authorities having jurisdiction as well as to the City. Spoil areas shall be located so as not to create hazardous shoals or raise the natural bottom to a degree that would be dangerous or unsightly. Any discharge pipelines which leak that act to build up deposits of wasted material, shall be immediately repaired so that dredged material is deposited only in the areas intended. If dredged material is to be loaded in scows and transported, this shall be done in a manner that will not permit spillage or waste of the material in areas not designated as spoil areas.

D. Equipment used shall be adequate for the requirements of the Work to be done, and shall be provided with proper warnings, signals, lights, etc., and is subject to approval by the Engineer before being used on the project. All equipment when not in use must be moored beyond the limits of navigation channels and be properly equipped with warning, signals, lights, etc.

E. It will be the Contractor's responsibility to determine the location of submarine cables, pipe lines or other structures in the area whether submerged or visible and to keep its dredging operations a sufficient distance from such structures so that their safety and stability will not be impaired.

F. When so noted in the Special Provisions, the Contractor may be required to supply living quarters, subsistence or office space or all of these for the use of Inspectors and also an adequate work boat for the use of the Inspector in making soundings, etc.

PART 4 MEASUREMENT AND PAYMENT

A. Dredging will be measured only when specifically noted in the Special Provisions. Unless otherwise noted, dredging will be measured in place, in its original position, within the prescribed pay limits as shown on the plans or described in the Special Provisions. Measurements will be made by means of cross sections and soundings taken before and after dredging is done and volumes will be computed by average end areas, from the cross sections of the original ground combined with prescribed pay limits of the completed Work.

B. If so noted in the Proposal, volumes of dredging material may be computed by means of scow measurements and the details of such method shall be as stated in the Proposal or as agreed upon by the Contractor and the Engineer before the Work is started, but cross sections will still be taken both before and after the dredging is done.

C. Dredging will be paid for only when a specific item for it is included in the Proposal and payment will then be made only for material actually removed. Under these conditions Dredging will be paid for on the basis of the Contract Unit Price per cu. yd. This price shall be full compensation for all labor, equipment, dredge, scow, pipe lines and material necessary to complete the Work and no additional compensation will be allowed for any incidentals such as obtaining necessary permits, complying with applicable laws and regulations, removing material or obstructions projecting within the neat lines, protecting submerged or visible structures within or adjacent to dredged areas, etc.

D. Over dredging will be paid for up to, but not beyond, a specified distance outside of the limits of the typical cross section as shown on the plans.

E. When it is specified or agreed that payment is to be on the basis of scow measurement, over dredging will be paid for only to the limits noted above. The volume of any over dredging beyond these limits will be computed by average end areas, from the cross sections of the original ground combined with cross sections of the completed Work and then, unless otherwise noted, or agreed upon, the volume of excess over dredging so computed will be increased by twenty percent (20%) to compensate for bulking in the scows, and this adjusted or increased volume will be deducted from the quantity for payment as computed from the scow measurements.

F. When the Contractor is required to furnish living quarters, subsistence, workboat, office space or any combination thereof, the payment shall be made at the lump sum price for these services.

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