

SWSP Standard Specifications

- Not all specs may be required for a project.
- DPOR to confirm if individual specifications are needed.
- 01110 – Summary of Work will be developed specifically for each individual project
- Cathodic Protection Specs will be developed for each project

Section 01145

USE OF PREMISES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General use of the site including properties inside and outside of rights-of-way, work affecting road, ramps, streets and driveways and notification to adjacent occupants.

1.2 RIGHTS-OF-WAY

- A. Confine access, and operations and storage areas to rights-of-way provided by the Authority as stipulated in the General Conditions of the Construction Contract; trespassing on abutting lands or other lands in the area is not allowed.
- B. Make arrangements, at no cost to the Authority for temporary use of private properties. Contractor and Surety shall indemnify and hold harmless the Authority against claims or demands arising from such use of properties outside of rights-of-way. Submit a copy of agreements between private property owners and Contractor prior to use of the area. Agreements between private property owners and Contractor shall be notarized or bear the signatures of two witnesses.
- C. Restrict total length of distributed materials along the route of construction to 1,000 linear feet unless otherwise approved in writing by Engineer.
- D. Maintain TxDOT and Harris County Right-Of-Way at all times, including keeping pavement clean and preventing erosion to roadside ditches and other areas. Regularly mow grass lined ditches and other Right-Of-Way areas which receive discharged water from construction activities. No separate pay.

1.3 PROPERTIES OUTSIDE OF RIGHTS-OF-WAY

- A. Do not alter the condition of properties adjacent to and along rights-of-way.
- B. Do not use ways, means, methods, techniques, sequences, or procedures that result in damage to properties or improvements.
- C. Restore damaged properties outside of rights-of-ways at no cost to the Authority, unless otherwise indicated in the Construction Documents and Contract Documents.

1.4 USE OF SITE

- A. Obtain approvals from governing authorities prior to impeding or closing public roads and

streets. Do not close more than two consecutive intersections at one time.

- B. Notify Engineer, Houston Public Works Traffic Management Branch, and Harris County Engineering Department, as may be applicable, at least five working days prior to closing a street or street crossing. Obtain permits for street closures in advance.
- C. Maintain 10-foot-wide minimum access lanes for emergency vehicles including access to fire hydrants.
- D. Avoid obstructing drainage ditches or inlets. When obstruction is unavoidable due to requirements of the Work, provide grading and temporary drainage structures to maintain unimpeded flow.
- E. Locate and protect private lawn sprinkler systems that may exist within the site. Repair or replace damaged systems to condition existing at start of the Work, or better. Test irrigation system prior to construction.
- F. Perform daily clean up in affected construction areas in order to restore site to existing or better conditions. Areas should be free of debris, scrap material, dirt, mud, and other items identified by Engineer. Do not leave buildings, roads, streets, and other construction areas unclean.
- G. Restore damaged landscaping, other than landscaping designated for removal, to condition existing at start of Work, or better.
- H. Beware of overhead power lines existing in area and in close proximity of the Project. When 10 feet of clearance between energized overhead power line and construction-related activity cannot be maintained, request Center Point Energy (CPE) de-energize or move conflicting overhead power line. Contact CPE representatives at (713) 207-2222. Schedule, coordinate and pay costs associated with de-energizing or moving conflicting overhead power lines. When there is no separate pay item for this effort, include these costs in various items of bid that make such work necessary.
- I. Accessibility to easement along Project alignment is limited after rainfall events. Provide necessary means to maintain access at all times. No separate pay. No extra days will be granted for inaccessibility to the site.
- J. Maintain access to all Metro bus stops. Replace Metro bus sign (Stop) and temporary pedestrian pad/shelter along routed road for Metro passenger pick-up/drop-off if required.
- K. Protect and maintain existing fences within construction limit and in near vicinity as necessary.
- L. Restore drainage swale and channel to the original condition or better if damaged.

1.5 NOTIFICATION TO ADJACENT OCCUPANTS

- A. Notify individual occupants in areas to be effected by the Work of proposed construction and timing schedule. If no specific notification timeframe or coordination requirement is described in the easement documents, the Contractor will provide notification not less than 72 hours or more than two weeks prior to work performed within 200 feet of homes or businesses. Otherwise follow requirements set forth in the easement documents, and summarized in 01110 – Summary of Work. Follow form and content of sample door hanger provided by Engineer.
- B. Include in notification nature of the Work, and names and telephone numbers of two company representatives for resident contact available on 24-hour call.
- C. Submit proposed notification to Engineer for approval. Consider ethnicity of the neighborhood where English is not the dominant language. Provide notice in an understandable language.
- D. Contactor will attempt to hand deliver notices to effected occupants, leaving behind a door hangar as described above if occupants are not present. Door hangar is to be left well secured by an appropriately sized rubber band.

1.6 PUBLIC, TEMPORARY, AND CONSTRUCTION ROADS AND RAMPS

- A. Construct and maintain temporary detours, ramps, and roads to provide for normal public traffic flow when it is necessary to close public roads or streets.
- B. Provide mats or other means to prevent overloading or damage to existing roadways from tracked equipment, large tandem axle trucks or equipment that will damage the existing roadway surfaces.
- C. Construct and maintain access roads and parking areas as specified in Section 01504- Temporary Facilities and Controls.

1.7 EXCAVATION IN STREETS AND DRIVEWAYS

- A. Avoid hindering or inconveniencing public travel on streets or intersecting alleys for more than two blocks at any one time, except by permission of the Engineer.
- B. Obtain approval from Houston Public Works Traffic Management Branch, Harris County Engineering Department, and Engineer when nature of the Work requires closure of an entire street. Permits required for street closure are Contractor's responsibility. Avoid unnecessary inconvenience to abutting property owners.
- C. Remove surplus materials and debris and open each block for public use, as work in that block is complete.
- D. Acceptance of any portion of the Work will not be based on return of street to public use.

- E. Avoid obstructing driveways or entrances to private property.
- F. Provide temporary crossings or complete excavation and backfill in one continuous operation to minimize duration of obstruction when excavation is required across drives or entrances.
- G. Provide barricades and signs in accordance with Section VI of the State of Texas Manual on Uniform Traffic Control Devices.

1.8 TRAFFIC CONTROL

- A. Comply with traffic regulation as specified in Section 01555 - Traffic Control and Regulation.

1.9 SURFACE RESTORATION

- A. Restore the site including landscaping to the condition existing before construction, or better.
- B. Repair paved areas per the requirements of Section 02951 - Pavement Repair and restoration.
- C. Repair damaged turf areas, level with bank run sand conforming to Section 02317 - Excavation and Backfill for Utilities, or topsoil conforming to Section 02911 - Topsoil, and re-sod in accordance with Section 02922 - Sodding. Water and level newly sodded areas with adjoining turf using appropriate steel wheel rollers for sodding. Do not use spot sodding or sprigging. Where indicated, reseed in accordance with Section 02921- Hydromulch Seeding.

1.10 LIMITS OF CONSTRUCTION

- A. Confine operations to lands within construction work limits shown on Drawings. Unless otherwise noted on Drawings adhere to the following:
 - 1. Where utility alignment is within esplanade, and construction limits are shown on Drawings to extend to edge of esplanade, keep equipment, materials, stockpiles a minimum of five feet from back of curb.
 - 2. Where construction limits shown on Drawings extend to property line, keep sidewalks free of equipment, materials, and stockpiles.

1.11 EQUIPMENT AND MATERIAL SALVAGE

- A. Upon completion of the Work, carefully remove salvageable equipment and material. Deliver them to Authority as directed by Engineer. Dispose of equipment offsite at no

additional cost to the Authority when Engineer deems equipment unfit for further use.

1.12 COORDINATE WITH OTHER AGENCIES

- A. Coordinate work with adjacent contractors on access to the site. Avoid obstructing the other agencies' work.
- B. Refer to Section 01110 for additional information.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01255

CHANGE ORDER PROCEDURES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Procedures for processing Change Orders, including:
 - 1. Assignment of a responsible individual for approval and communication of changes in the Work;
 - 2. Documentation of change in Contract Price and Contract Time;
 - 3. Change procedures, using proposals and Modifications;
 - 4. Execution of Change Orders;
 - 5. Correlation of Contractor submittals.

1.2 REFERENCES

- A. Blue Book is defined as the Rental Rate Blue Book for Construction Equipment (a.k.a. Data Quest Blue Book).
- B. Rental Rate is defined as the full-unadjusted base rental rate for the appropriate item of construction equipment.

1.3 RESPONSIBLE INDIVIDUAL

- A. Provide a letter indicating the name and address of the individual authorized to execute Modifications, and who will be responsible for informing others in Contractor's employ and Subcontractors of changes to the Work. Provide this information at the pre-construction meeting.

1.4 DOCUMENTATION OF CHANGE IN CONTRACT PRICE AND CONTRACT TIME

- A. Maintain detailed records of changes in the Work. Provide full information required for identification and evaluation of proposed changes, and substantiate costs of changes in the Work.
- B. Document each proposal for change in Contract Price or Contract Time with sufficient data to allow evaluation of proposal

- C. Include the following minimum information on proposals:
 - 1. Quantities of items in original Bid Form with additions, reductions, deletions, and substitutions.
 - 2. Quantities and cost of items in original Schedule of Values with additions, reductions, deletions and substitutions.
 - 3. Provide Unit Prices for new items, with supporting information, for inclusion in Schedule of Unit Price Work.
 - 4. Justification for changes in Contract Time.
 - 5. Additional data upon request.
- D. Documents are to be submitted electronically in *PDF format. No printed copies will be accepted for review unless original signature is required and the document has been input to the WHCRWA FTP site.
- E. For changes in the Work performed on a time-and-material basis, provide the following additional information:
 - 1. Quantities and description of Products.
 - 2. Taxes, insurance and Bonds.
 - 3. Overhead and profit as noted in the General Conditions of the Construction Contract.
 - 4. Dates, times and by who work was performed.
 - 5. Time records and certified copies of applicable payrolls.
 - 6. Invoices and receipts for Products, rental equipment, and subcontracts, similarly documented.
- F. For changes in the Work performed on a time-and-materials basis, rental equipment is paid as follows:
 - 1. Actual invoice cost for duration of time required to complete extra work without markup for overhead and profit. When extra work comprises only a portion of a rental invoice where equipment would otherwise be on site, compute hourly equipment rate by dividing the actual monthly invoice by 176. One day equals eight hours and one week equals 40 hours.

2. Do not exceed estimated operating costs given in Blue Book for items of equipment. Overhead and profit will be allowed on the operating cost.
- G. For changes in the Work performed on a time-and-materials basis using Contractor-owned equipment, use Blue Book rates as follows:
1. Contractor-owned equipment will be paid at the Blue Book Rental Rate for the duration of time required to complete extra work without markup for overhead and profit. Utilize lowest cost combination of hourly, daily, weekly or monthly rates. Use 150 percent of Rental Rate for double shifts, one extra shift per day, and 200 percent of Rental Rate for more than two shifts per day. Standby rates shall be 50 percent of the appropriate Rental Rate shown in Blue Book. No other rate adjustments apply.
 2. Do not exceed estimated operating costs given in Blue Book. Overhead and profit will be allowed on operating costs. Operating costs will not be allowed for equipment on standby.

1.5 CHANGE PROCEDURES

- A. Changes to Contract Price or Contract Time can only be made by issuance of Change Order. Issuance of Work Change Directive will be formalized into a Change Order. Changes will be in accordance with requirements of the General Conditions of the Construction Contract.
- B. Engineer will advise of minor changes in the Work as authorized by the the General Conditions of the Construction Contract by issuing supplemental instructions.
- C. Request clarification of Drawings, Specifications, Contract documents or other information by using Request for Information. Response by Engineer to Requests for Information does not authorize Contractor to perform tasks outside scope of the Work. Changes must be authorized as described in this Section.

1.6 PROPOSALS AND CONTRACT MODIFICATIONS

- A. Engineer may issue Request for Proposal, which includes a detailed description of the proposed change with supplementary or revised Drawings and Specifications. Engineer may also request a proposal in response to a Request for Information. Prepare and submit the proposal within seven days or as specified in request.
- B. Submit requests for Contract changes to Engineer describing proposed change and its full effect on the Work, with a statement describing reason for change and effect on Contract Price and Contract Time including full documentation.
- C. DPOR may review Change Orders.

1.7 WORK CHANGE DIRECTIVE

- A. Engineer may issue a signed Work Change Directive instructing Contractor to proceed with a change in the Work. Work Change Directive will subsequently be incorporated into a Change Order.
- B. Work Change Directives will describe changes in the Work and designate the method of determining change in Contract Price or Contract Time.
- C. Proceed promptly to execute changes in the Work in accordance with the Work Change Directive.

1.8 STIPULATED PRICE CHANGE ORDER

- A. A Stipulated Price Change Order will be based on an accepted proposal.

1.9 UNIT PRICE CHANGE ORDER

- A. Where Unit Prices for affected items of the Work are included in Exhibit 1 – Contractor’s Bid, the Change Order will be based on Unit Prices of the General Conditions of the Construction Contract.
- B. Where Unit Prices of the Work are not pre-determined in Exhibit 1 – Contractor’s Bid, the Work Change Directive or accepted proposal will specify the Unit Prices to be used.

1.10 TIME-AND-MATERIAL CHANGE ORDER

- A. Provide itemized account and supporting data after completion of change, within time limits indicated for claims in –the General Conditions of the Construction Contract.
- B. Engineer will determine the change allowable in Contract Price and Contract Time as provided in the General Conditions of the Construction Contract.
- C. Maintain detailed records for work done on time-and-material basis as specified in Paragraph 1.4 above.
- D. Provide full information required for evaluation of changes and substantiate costs for changes in the Work.

1.11 EXECUTION OF CHANGE DOCUMENTATION

- A. Engineer will issue Change Orders, Work Change Directives, or minor change in the Work for signatures of Parties as described in the General Conditions of the Construction Contract.

1.12 CORRELATION OF CONTRACTOR SUBMITTALS

- A. For Stipulated Price Contracts, promptly revise schedule of values and Application for Payment forms to record authorized Change Orders as separate line item.
- B. For Unit Price Contracts, the next monthly estimate of the Work after acceptance of a Change Order will be revised to include new items not previously included with appropriate Unit Prices.
- C. Promptly revise progress schedules to reflect change in Contract Time, and to adjust time for other items of work affected by the change, and resubmit for review.
- D. Promptly enter changes to on-site and record copies of Drawings, Specifications or Contract documents as required in Section 01785 - Project Record Documents.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01270

MEASUREMENT AND PAYMENT

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Procedures for measurement and payment plus conditions for nonconformance assessment and nonpayment for rejected Products.

1.2 AUTHORITY

- A. Measurement methods delineated in Specification sections are intended to complement criteria of this Section. In event of conflict, requirements of the Specification section shall govern.
- B. Engineer will take all measurements and compute quantities accordingly.
- C. Assist by providing necessary equipment, workers, and survey personnel.
- D. Measurement and Payment paragraphs are included only in those Specification sections of Division 01 where direct payment will be made. Include costs in the total bid price for those Specification sections in Division 01 that do not contain Measurement and Payment paragraphs.

1.3 UNIT QUANTITIES SPECIFIED

- A. Quantity and measurement estimates stated in the Agreement are for contract purposes only. Quantities and measurements supplied or placed in the Work and verified by Engineer will determine payment as stated in Article 9 of the General Conditions of the Construction Contract.
- B. When actual work requires greater or lesser quantities than those quantities indicated in Exhibit 1 – Contractor's Bid, provide required quantities at Unit Prices contracted, except as otherwise stated in Article 9 of the General Conditions of the Construction Contract.

1.4 MEASUREMENT OF QUANTITIES

- A. Measurement by Weight: Reinforcing steel, rolled or formed steel or other metal shapes are measured by CRSI or AISC Manual of Steel Construction weights. Welded assemblies are measured by CRSI or AISC Manual of Steel Construction or scale weights.

- B. Measurement by Volume:
 - 1. Stockpiles: Measured by cubic dimension using mean length, width, and height or thickness.
 - 2. Excavation and Embankment Materials: Measured by cubic dimension using average end area method.
- C. Measurement by Area: Measured by square dimension using mean length and width or radius.
- D. Linear Measurement: Measured by linear dimension, at item's horizontal centerline or mean chord.
- E. Stipulated Price Measurement: By unit designated in the Agreement.
- F. Other: Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed item or unit of the Work.
- G. Measurement by Each: Measured by each instance or item provided.
- H. Measurement by Lump Sum: Measure includes all associated work.

1.5 PAYMENT

- A. Payment includes full compensation for all required supervision, labor, Products, tools, equipment, plant, transportation, services, and incidentals; and erection, application or Installation of an item of the Work; and Contractor's overhead and profit.
- B. Total compensation for required Unit Price work shall be included in Unit Price bid in Exhibit 1 – Contractor's Bid. Claims for payment as Unit Price work, but not specifically covered in the list of Unit Prices contained in Exhibit 1 – Contractor's, will not be accepted.
- C. Interim payments for stored materials will be made only for materials to be incorporated under items covered in Unit Prices, – in accordance with the General Conditions of the Construction Contract and the Supplementary Conditions.
- D. Progress payments will be based on Engineer's observations and evaluations of quantities incorporated in the Work multiplied by Unit Price.
- E. Final payment for work governed by Unit Prices will be made on the basis of actual measurements and quantities determined by Engineer multiplied by the Unit Price for work which is incorporated in or made necessary by the Work.

1.6 PAYMENT FOR STORED MATERIALS AND EQUIPMENT

- A. Payment will be made for materials and equipment stored properly at the Site, provided that the materials and equipment are complete and ready for installation.
 - 1. Payment will be made for the invoice amount less the specified retainage in accordance with the General Conditions of the Construction Contract.
 - 2. Payment for stored materials and equipment shown in the Payment Application will be made for the invoice amount, up to the value shown in the Schedule of Values for that line item. Costs for material and equipment in excess of the value shown in the schedule of values may not be added to other line items.
 - 3. Payment will be made in full for the value shown in the line item for products and materials if invoices for materials and equipment are less than the amount shown in the line item and it can be demonstrated that no additional materials or equipment are required to complete Work described in that item.
 - 4. Provide invoices for stored materials and equipment at the time materials and equipment are included in the Payment Application on a Tabulation of Value for Stored Materials and Equipment. Include invoice numbers on the Tabulation of Value for Stored Materials and Equipment so that a comparison can be made between invoices and amounts included on the tabulation.
- B. Payment will be made for steel coil stored in the pipe production facilities. Refer to Section 02518 – Steel Pipe and Fittings for Large Diameter Water Lines.
- C. Provide documentation of payment for stored materials and equipment with the next Payment Application. Adjust payment to the amount actually paid if this differs from the invoice amount. Remove items from the Tabulation of Value for Stored Materials and Equipment if this documentation is not provided. Payment will not be made for material and equipment without documentation of payment.
- D. Payment for materials and equipment does not constitute acceptance of the product.
- E. Transfer of Ownership. The Work covered by progress payments becomes the property of the Owner at the time of payment. The Contractor's obligations with regard to proper care and maintenance, insurance, and other requirements are not changed by this transfer of ownership until accepted in accordance with the General Conditions.

1.7 NONCONFORMANCE ASSESSMENT

- A. Remove and replace work, or portions of the Work, not conforming to the Contract documents.

- B. When not practical to remove and replace work, Engineer will direct one of the following remedies:
 - 1. Nonconforming work will remain as is, but Unit Price will be adjusted lower at discretion of Engineer.
 - 2. Nonconforming work will be modified as authorized by Engineer, and the Unit Price will be adjusted lower at the discretion of Engineer when modified work is deemed less suitable than specified.
- C. Specification sections may modify the above remedies or may identify a specific formula or percentage price reduction.
- D. Authority of Engineer to assess nonconforming work and identify payment adjustment is final.

1.8 NONPAYMENT FOR REJECTED PRODUCTS

- A. Payment will not be made for any of the following:
 - 1. Products wasted or disposed of in an unacceptable manner.
 - 2. Products determined as nonconforming before or after placement.
 - 3. Products not completely unloaded from transporting vehicles.
 - 4. Products placed beyond lines and levels of required work.
 - 5. Products remaining on hand after completion of the Work, unless specified otherwise.
 - 6. Loading, hauling, and disposing of rejected Products.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01292

SCHEDULE OF VALUES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Preparation and submittal of Schedule of Values for Stipulated Price Contracts or for Major Unit Price Work on Unit Price Contracts.

1.2 PREPARATION

- A. For Stipulated Price Contracts, subdivide the Schedule of Values into logical portions of the Work, such as major work items or work in contiguous construction areas. Use Section 01325 - Construction Schedule as a guide to subdivision of work items. Directly correlate Items in the Schedule of Values with tasks in the Construction Schedule. Organize each portion using the Project Manual Table of Contents as an outline for listing value of the Work by Sections. A pro rata share of mobilization, Bonds, and insurance may be listed as separate items for each portion of the Work.
- B. For Unit Price Contracts, items should include a proportional share of Contractor's overhead and profit so that total of all items will equal Contract Price.
- C. For lump sum equipment items, where submittal of operation and maintenance data and testing are required, include separate items for equipment operation and maintenance data where:
 - 1. submittal of maintenance data is valued at five percent of the lump sum amount for each equipment item and
 - 2. submittal for testing and adjusting is valued at five percent of the lump sum amount for each equipment item.

Round off figures for each item listed to the nearest \$100. Set the value of one item, when necessary, to make total of all values equal the Contract Price for Stipulated Price Contracts or the lump sum amount for Unit Price Work.

- D. Submit Schedule of Values electronically using WHCRWA FTP site in approved electronic file or *.PDF.

1.3 SUBMITTAL

- A. Submit the Schedule of Values, in accordance with requirements of Section 01330 - Submittal Procedures, at least 10 days prior to submitting first application for progress payment.
- B. Submit the Schedule of Values in an approved electronic spreadsheet file and an 8 1/2 - inch by 11 - inch print on white bond paper.
- C. Revise Schedule of Values for items affected by Contract Modifications. After Engineer has reviewed changes, resubmit at least 10 days prior to the next application for progress payment.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01312

COORDINATION AND MEETINGS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. General coordination including pre-construction meeting, site mobilization conference, and progress meetings.

1.2 COORDINATION OF DOCUMENTS

- A. Coordination is required throughout documents. Refer to Contract Documents and coordinate as necessary.

1.3 CONTRACTOR COORDINATION

- A. Coordinate scheduling, submittals, and work of various Specification sections to assure efficient and orderly sequence of Installation of interdependent construction elements.
- B. Coordinate completion and clean-up of the Work prior to the date of Substantial Completion and for portions of the Work designated for Authority's partial occupancy.
- C. Coordinate access to the site for correction of nonconforming work to minimize disruption of the Authority's activities where the Authority is in partial occupancy.
- D. Coordination shall be tracked using WHCRWA FTP site.

1.4 PRE-CONSTRUCTION MEETING

- A. Engineer will schedule pre-construction meeting.
- B. Attendance Required: Authority representatives, Design Professional of Record (DPOR), special consultants as required by Engineer, Contractor, and major Subcontractors and Suppliers.
- C. Agenda:
 - 1. Distribution of Contract documents.
 - 2. Designation of personnel representing the Parties and Design Professional of Record.
 - 3. Review of insurance.

4. Discussion of formats for Schedule of Values and Construction Schedule.
5. Procedures and processing of Shop Drawings, substitutions, pay estimates or Applications for Payment, Requests for Information, Requests for Proposal, Modifications, contract closeout procedures, and other submittals.
6. Scheduling of the Work and coordination with other contractors.
7. Review of Subcontractors and Suppliers.
8. Appropriate agenda items listed for the site mobilization conference, indicated in Paragraph 1.5.C below, when pre-construction meeting and site mobilization conference are combined.
9. Procedures for testing.
10. Procedures for maintaining record documents.

1.5 SITE MOBILIZATION CONFERENCE

- A. When required by Contract Documents, Engineer will schedule a conference at the Project site prior to Contractor mobilization.
- B. Attendance Required: Authority representatives, Engineer, Design Professional of Record, special consultants, Superintendent, and major Subcontractors.
- C. Agenda:
 1. Use of premises by the Authority and Contractor.
 2. Safety and first aid procedures.
 3. Construction controls provided by the Authority.
 4. Temporary utilities.
 5. Survey and layout.
 6. Security and housekeeping procedures.
 7. Field office requirements

1.6 PROGRESS MEETINGS

- A. Hold meetings at Project field office or other location designated by Engineer or

Resident Project Representative (RPR). Hold meetings at monthly intervals, or more frequently when directed by Engineer.

- B. Attendance Required: Superintendent, major Subcontractors and Suppliers, Authority representatives, Engineer (attendance is optional depending on meeting agenda topics), Resident Project Representative (RPR), Design Professional of Record (DPOR), and its sub-consultants as appropriate for agenda topics for each meeting.
- C. RPR will make arrangements for meetings
- D. DPOR will be responsible for recording meeting minutes and distributing to attending parties.
- E. Engineer or RPR will prepare the agenda and preside at meetings.
- F. Provide required information and be prepared to discuss each agenda item.
- G. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of construction schedule, pay estimates, cash flow curve, payroll and compliance submittals.
 - 3. Field observations, problems, and necessary decisions.
 - 4. Identification of problems that impede planned progress.
 - 5. Review of submittal schedule and status of submittals.
 - 6. Review of RFI and RFP status.
 - 7. Modification status.
 - 8. Review of off-site fabrication and delivery schedules.
 - 9. Maintenance of Construction Schedule.
 - 10. Corrective measures to regain Construction Schedule.
 - 11. Planned progress during the succeeding work period.
 - 12. Coordination of projected progress.
 - 13. Maintenance of quality and work standard.

14. Effect of proposed Modifications on Construction Schedule and coordination.
15. Review Project Record Contract Drawings.
16. Other item relating to the Work.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

Section 01321

CONSTRUCTION PHOTOGRAPHS
AND VIDEO RECORDING

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Photography and video recording (videos) requirements for construction photographs, videos and submittals.

1.2 MEASUREMENT AND PAYMENT

- A. Photography and videos will not be measured or paid for separately. Include cost in the various bid items.

1.3 DEFINITIONS

- A. Digital Photography: Photographs taken with a digital camera with minimum pixel size 3904 x 2598 (10.1 MegaPixels).
- B. Digital Video Recordings (Videos): Digital videos taken with a digital video recorder to produce high definition videos (HD) with minimum pixel size 1280 x 1080p and aspect ratio of 16 x 9.
- C. Pre-construction Photographs and Videos: Digital photographs and videos taken in sufficient numbers and detail, prior to the date of the Notice To Proceed, to document original construction site conditions.
- D. Progress Photographs and Videos: Digital photographs and videos taken throughout the duration of construction at regular intervals and from fixed vantage points that document progress of the Work.
- E. Finished Photographs and Videos: Digital photographs and videos taken in sufficient numbers and detail, after the date of Substantial Completion and before submittal of the final Application for Payment, to document construction improvements and condition of the site.

1.4 SUBMITTALS

- A. Refer to Section 01330, Submittal Procedures, for submittal requirements and procedures.

B. Resolution, Format and Media.

1. Submit color photographs and videos, unless otherwise specified.
2. Digital Photography: Minimum 3904 x 2598 pixels (10.1 Megapixel) density or greater, 16 x 9 aspect ratio.
3. Digital Videos: HD (high definition, minimum 1080p.
4. Submit digital photographs and videos in digital format as follows:
 - a. Photographs: Format in JPEG (Joint Photographic Experts Group).
 - b. Videos: Format in MP4.
5. Media. Submit digital photographs and videos by one of the following media methods:
 - a. USB flash drive.
 - b. Upload files to construction management software used by Resident Project Representative (RPR). Coordinate with RPR for software access and folder location for uploading files.

C. Submittal Quantities and Frequencies.

1. Pre-construction Photographs and Videos:
 - a. Submit prior to starting construction activities (before mobilization of equipment, supplies or materials).
2. Progress Photograph and Videos:
 - a. Submit with each Application for Payment at the times established for submittal of Applications for Payment. Monthly Applications for Payment shall be deemed incomplete if not accompanied by the required Progress Photographs and Videos. Contractor's failure or election to not submit a monthly Application for Payment shall not affect the requirement for monthly Progress Photographs and Videos.
3. Finished Photographs and Videos:
 - a. Submit after Date of Substantial Completion and prior to final Application for Payment.

D. File Naming. Photograph and video files shall be named for identification using the

following filename format:

[Year Month Day]_[ProjectName]_[Site Location or Approximate Station]_[Description/Photo Direction (N/S/E/W)].jpeg(MP4)

Ex. 20200311_SegA_Sta3+00_LookingNorth.jpeg

The above example is for a photograph taken on March 11, 2020 in Segment A looking north at approximate project Station 331.

1. Provide a listing of abbreviations used for the filename components [Site Location] and [Description]. Use abbreviations similar to above example.

1.5 QUALITY ASSURANCE

- A. Contractor shall be responsible for the quality of and timely execution and submittal of photographs and videos.
- B. Engineer shall review submittals to verify quality of photographs and videos. If Engineer determines quality of photographs and videos do not comply with the minimum requirements of this specification section, Contractor shall re-take photographs and videos to comply with the specification requirements and resubmit to the Engineer at no additional cost to the Owner.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PRE-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

- A. Content. Prior to the date of the Notice To Proceed, photograph and video the site to document site conditions, including areas not to be disturbed along the site perimeter, areas for proposed site ingress/egress, areas for staging or storage of equipment and materials, and other visibly notable features of the site.
- B. Videos are not required but are encouraged for documenting pre-construction site conditions.

3.2 PROGRESS PHOTOGRAPHS AND VIDEOS

- A. Content. Progress Photographs shall document monthly advancement of the Work. Select vantage points for each photograph so as to best show status of construction and progress since last photograph submittal. Select camera stations that will require little or no movement or adjustment over the duration of construction.

- B. Frequency. Take monthly Progress Photographs at regular intervals to coincide with cutoff dates associated with each Application for Payment.
- C. Videos are not required but are encouraged for documenting Work progress conditions.

3.3 FINAL PHOTOGRAPHS AND VIDEOS

- A. Content. After Substantial Completion and before Final Completion, photograph and video the site to document site conditions, including site improvements, constructed facilities, and areas designated not to be disturbed by construction along the site perimeter.
- B. Videos are not required but are encouraged for documenting post-construction site conditions.

END OF SECTION

Section 01325

CONSTRUCTION SCHEDULE

PART 1 G E N E R A L

1.1 GENERAL

- A. Provide Construction Schedules for the Work included in this Contract in accordance with requirements in this Section, pursuant to the General Conditions. Create Construction Schedule using Critical Path Method (CPM) with Oracle Primavera P6, which is the required software for meeting the requirements of this specification.
- B. A P6 Construction Schedule Template will be provided to populate with schedule activities. This template will have a Work Breakdown Structure (WBS) and Activity Codes that the contractor is expected to use and assign to their activities to as appropriate. The template will facilitate integration of Contractor schedules across the Surface Water Supply Project.
- C. Show in the schedule the sequence in which the Contractor proposes to perform the work and dates on which the Contractor contemplates starting and completing all schedule activities. The scheduling of the entire project, including the submittal, procurement and construction sequences, is required. The scheduling of construction is the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate Construction Schedule. Include dates for key milestones and other major components of the Work, and the times when certain information and/or approvals from the Engineer are required. Critical tasks comprising the Critical Path shall be precisely identified by the Contractor in its Construction Schedule and each progress schedule through implementation of the Critical Path Method ("CPM").
- D. Use the approved Construction Schedule to measure the progress of the work and to aid in evaluating time extensions. Make the schedule cost loaded and activity coded. The schedule will provide the basis for all progress payments. If the Contractor fails to submit any schedule within the time prescribed, the Engineer may withhold approval of progress payments until the Contractor submits the required schedule.
- E. Combine activity listings and bar charts with narrative report to form Construction Schedule submittal for Engineer.

1.2 SCHEDULING STAFF

- A. Employ or retain services of individual experienced in CPM scheduling for duration of the Contract. Individual shall cooperate with Engineer and update schedule monthly as required to indicate current status of the Work. The scheduler shall be experienced in scheduling and have previously developed, created, and maintained at least two (2) electronic schedules for projects similar in nature and complexity to this project, and shall be experienced in the use Oracle Primavera P6.

1.3 SUBMITTALS

Within 30 days after the Notice to Proceed, Contractor shall submit the Construction Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including the Critical Path and any Milestones specified in the Contract and detailed in this specification. Conform to requirements of Section 01330 - Submittal Procedures. Submit electronic schedule in *.PDF and Primavera P6 *.XER format (or other format as requested) to the WHCRWA Project Management Information System Software, Orion.

The 30-day schedule drafting period is further broken down by interim scope and time intervals in the following Sections A and B.

A. Preliminary Construction Schedule Submission

Submit the Preliminary Construction Schedule, defining the Contractor's planned operations for the duration of the Contract for approval no later than 10 calendar days after Notice to Proceed. Completely cost load the Preliminary Construction Schedule to balance the contract award shown on the Price Schedule. Also cover in the preliminary schedule the entire construction effort with as much detail as is known at the time but, as a minimum, include all construction start and completion milestones, and detailed construction activities, including all activity coding and cost loading. The Preliminary Construction Schedule forms the basis for the Approved Construction Schedule specified herein and must include all of the required Plan and Program preparations, submissions and approvals identified in the contract (for example, Quality Control Plan, Safety Plan, and Environmental Protection Plan) as well as the planned submissions of all activities intended to occur within Contract Period. Show planned construction activities by Engineer acceptance of the associated package(s) and all other specified Program and Plan approvals.

B. Approved Construction Schedule

Submit the Construction Schedule for approval within 15 calendar days after Engineer acceptance of the Preliminary Construction Schedule for the contract. The schedule shall incorporate all comments provided to the Contractor on the Preliminary Construction Schedule. The Construction Schedule shall demonstrate a reasonable and realistic sequence of activities which represent all work through the entire contract performance period. The Construction Schedule shall be at a reasonable level of detail as determined

by the Engineer. Include in the schedule detailed permitting activities, including but not limited to reviews and conferences; permit submissions and any required Engineer actions; and long lead item acquisition prior to completion.

C. Periodic Schedule Updates

These submissions will enable the Engineer to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and Construction Schedule data, which in the judgment of the Engineer or authorized representative is necessary for verifying the Contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made. Update the schedule to include detailed, lower WBS level construction activities as requested by the Engineer. The Engineer may require submission of detailed schedule activities for any distinct construction that is started prior to submission of Construction Schedule, if such activity is authorized.

Conform to requirements of Section 01330 - Submittal Procedures. Submit electronic schedule in *.PDF and Primavera P6 *.XER format (or other format as requested) to the WHCRWA Project Management Information System Software, Orion.

1.4 REQUIRED SCHEDULE ACTIVITIES

A. Notice to Proceed. (NTP)

B. Permit Activities: Include permit activities with the necessary conferences and follow-up actions and submission dates. This shall be at a detailed level of scheduling sufficient to identify all major permitting tasks, including those that control the flow of work. The schedule shall include review and correction periods associated with each item.

C. Procurement Activities: The schedule must include activities associated with the submittal, approval, procurement, fabrication and delivery of long lead materials, equipment, fabricated assemblies and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days. A typical procurement sequence includes the string of activities: prepare, submit, review, approve, procure, fabricate, and deliver.

D. Engineer Activities: Show Engineer and other agency activities that could impact progress. These activities include, but are not limited to the following:

1. Show approvals, reviews, environmental permit approvals by State regulators, inspections, utility tie-in or NTP for phasing requirements.
2. Show separate activities for each Shop Drawing and Product Data submittal critical to timely completion. Show submittal dates and dates Engineer needs to

provide approved submittals.

3. Show other activities as requested by the Engineer.
- E. Show major construction activities such as all mobilizations, initial site work, earthwork, pipe laying, by stationing, road to road crossing or other approved key areas; tunnel construction, pavement removal, pavement replacement, pressure testing, chlorination, clean up/site restoration, punch list, and all demobilizations as separate activities on the schedule.
- F. Open cut road crossings with detailed pavement replacement phasing.
- G. For projects with Major Unit Price Work, indicate Shop Drawing submittal and review, purchase, delivery, and Installation dates on Construction Schedule. Include activities for procurement, testing, adjustment, delivering O&M manuals and close out procedures.
- H. No task except the acquisition of Major Unit Price Work shall represent more than one percent of Original Contract Price for facility projects and three percent of Original Contract Price for other projects.
- I. For projects where operating facilities are involved, identify each period of work that will impact any process or operation in the schedule and that must be agreed to by Engineer and facility operator prior to starting work in the area.
- J. Include activities that show coordination with other Contractors where appropriate. For example, Tie-ins of a pipeline segment into a pump station facility (or another segment of pipeline outside of the Contractor's scope of work).

1.5 CONSTRUCTION SCHEDULE DETAILED REQUIREMENTS

- A. Develop the Construction Schedule to an appropriate level of detail. Provide separate horizontal bar for each activity. List start and finish date for each activity at left side of diagram. Failure to develop the Construction Schedule to an appropriate level of detail, as determined by the Engineer, will result in its disapproval. The Engineer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

1. Adhere to the following defaults for Primavera P6:

General	Notebook	Budget Log	Spending Plan	Budget Summary	Dates	Funding	Codes	Defaults	Resources	Settings	Calculations
Activities						Resource Assignments					
Default Price / Unit for activities without resource or role Price / Units: \$0.00/h						When updating Actual Units or Cost					
☐ Activity percent complete based on activity steps						☐ Add Actual to Remaining					
☒ Link Budget and At Completion for not started activities						☒ Subtract Actual from At Completion					
☐ Reset Original Duration and Units to Remaining						☒ Recalculate Actual Units and Cost when duration % complete changes					
☒ Reset Remaining Duration and Units to Original						☐ Update units when costs change on resource assignments					
						☒ Link actual to date and actual this period units and costs					

General	Notebook	Budget Log	Spending Plan	Budget Summary	Dates	Funding	Codes	Defaults	Resources	Settings	Calculations
Summarized Data				Project Settings							
Last Summarized On:				Character for separating code fields for the WBS tree: .							
Summarize to WBS Level: 1				Fiscal year begins on the 1st day of: January							
				Baseline for earned value calculations							
				☒ Project baseline ☐ User's primary baseline							
				Define Critical Activities							
				☐ Total Float less than or equal to: 0h							
				☒ Longest Path							

General	Notebook	Budget Log	Spending Plan	Budget Summary	Dates	Funding	Codes	Defaults	Resources	Settings	Calculations
Defaults for New Activities											
Duration Type: Fixed Duration & Units				Cost Account:							
Percent Complete Type: Physical				Calendar: 5 Day Work Week w/Holidays (Thru 01/01/27)							
Activity Type: Task Dependent											
Auto-numbering Defaults											
Activity ID Prefix: S3-A4				Activity ID Suffix: 1000				Increment: 10			
☒ Increment Activity ID based on selected activity											

The screenshot shows the 'User Preferences' dialog box with the 'Date Format' tab selected. On the left is a vertical list of tabs: Time Units, Dates, Currency, Assistance, Application, Password, Resource Analysis, Calculations, and Startup Filters. The 'Date Format' section contains three radio button options: 'Month, Day, Year', 'Day, Month, Year' (which is selected), and 'Year, Month, Day'. To the right, the 'Options' section includes checkboxes for '4-digit year' (unchecked), 'Month name' (checked), and 'Leading zeroes' (checked). Below these is a 'Separator' dropdown menu showing a hyphen '-'. The 'Time' section at the bottom has radio buttons for '12 hour (1:30 PM)', '24 hour (13:30)', and 'Do not show time' (which is selected). A checked checkbox for 'Show minutes' is also present. A 'Sample' text box at the bottom displays '05-Mar-20'. At the bottom right are 'Help' and 'Close' buttons.

The screenshot shows the 'User Preferences' dialog box with the 'Currency Options' tab selected. The left sidebar is identical to the previous screenshot. The 'Currency Options' section prompts the user to 'Select a currency for viewing monetary values' and features a dropdown menu currently set to 'US Dollar'. Below this, there are two checked checkboxes: 'Show currency symbol' (with a '\$' symbol to its right) and 'Show decimal digits' (with '0.00' to its right). At the bottom right are 'Help' and 'Close' buttons.

2. Activity ID: Following approval of the Construction Schedule, Activity IDs shall not be modified or changed. Engineer may require Contractor to use a standard nomenclature for Activity IDs.
3. Duration Type: Duration Type for all activities shall be set to “Fixed Duration and Units” for all non-milestone activity types.
4. Activity Description: Activity Descriptions shall contain a verb describing the work being performed such as “Install”, “Excavate”, “Repair”, etc. Where appropriate, the Contractor shall include the station for linear activities and/or a description of where the activity is being performed. It is expected that activities

similar in nature will have repetitive descriptions with the location varying to differentiate unique locations.

5. Activity Durations: Duration of tasks may not exceed 28 calendar days without prior Engineer approval. Ensure durations are appropriate and reasonable for the activity. Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods.
6. Activity Logic
 - a. Prohibited Logic
 - 1) Open Ends: All activities must have at least one predecessor (excluding NTP) and one successor (excluding End Project)
 - 2) Negative Lags: negative lags are prohibited
 - 3) Lags greater than 3 weeks (without Engineer's approval)
 - 4) Start-to-Finish relationships
 - 5) Constraints: Only milestones identified in the contract may be constrained.
 - b. Out-of-Sequence Progress
 - 1) Activities that have been performed before all preceding logic has been satisfied (Out-of-Sequence Progress) shall be corrected as part of the schedule update and documented in the schedule narrative. Out-of-Sequence Progress shall be allowed only on a case by case basis, and only with the approval of the Engineer.
7. Work Breakdown Structure: use the WBS provided in the Construction Schedule Template.
8. Activity Codes (such as Area Code, Activity Responsibility Coding, Category of Work Type, Definable Features of Work Coding, and Specification Section)
 - a. Activity Responsibility Coding (RESP): Assign responsibility Code for all activities to the Prime Contractor, Subcontractor or agency responsible for performing the activity. Activities coded with an Engineer Responsibility code include, but are not limited to: Engineer approvals, Engineer reviews, environmental permit approvals by State regulators and Notice to Proceed (NTP) for phasing requirements. Code all activities not coded with an Engineer Responsibility Code to the Prime Contractor or Subcontractor responsible to perform the work. Activities shall not have more than one Responsibility Code.
 - b. Category of Work Coding (CATW): Assign Category of Work Code to all Activities based upon the category of work to which the activity belongs. Category of Work Code must include, but is not limited to reviews, review conferences, permits, construction submittals, construction submittal approvals, Acceptance, Procurement, Fabrication,

Delivery, Start-Up, Test and Turnover. Assign a Category of Work Code to each activity. Each activity shall have only one Category of Work Code.

- c. Definable Features of Work Coding (FOW1, FOW2, FOW3): Assign a Definable Feature of Work Code to appropriate activities based on the definable feature of work to which the activity belongs. Definable Feature of Work shall be submitted to the Engineer for approval prior to use. An activity shall not have more than one Definable Feature of Work Code. Not all activities are required to be Definable Feature of Work Coded.
- d. Specification Section: Include primary specification section when applicable.
- e. Other Activity Codes as required by the Engineer to aid in the filtering, sorting, and analysis of schedule activities.

B. Scheduled Project Completion and Activity Calendars

The schedule interval shall extend from NTP date to the required contract completion date. The contract completion activity (End Project) shall finish based on the required contract duration in the accepted contract proposal, as adjusted for any approved contract time extensions. The first scheduled work period shall be the day after NTP is received by the Contractor. The Contractor shall schedule all work to be performed during the standard days and times defined in the contract documents. Work shall not be scheduled outside of these parameters without prior approval by the Engineer. Schedule activities on a calendar to which the activity logically belongs. Activities may be assigned to a 7-day calendar when the contract assigns calendar day durations for the activity such as an Engineer Acceptance activity. If the Contractor intends to perform physical work less than seven days per week, schedule the associated activities on a calendar with non-work periods identified including weekends and holidays.

Original durations must account for adverse weather. The Engineer will interpret all work periods not identified as non-work periods on each calendar as meaning the Contractor intends to perform work during those periods.

- 1. Project Start Date
The schedule shall start no earlier than the date on which the NTP was issued. Include as the first activity in the Construction Schedule an activity called "Start Project" (or NTP). The "Start Project" activity shall be a start milestone and have an "Early Start (ES)" constraint date equal to the date that the NTP was issued, and a zero-day duration.
- 2. Schedule Constraints and Open-Ended Logic

Constrain completion of the last activity in the schedule by the contract completion date. Schedule calculations shall result in a negative float when the calculated early finish date of the last activity is later than the contract completion date. Include as the last activity in the Construction Schedule an activity called "End Project" (or Final Completion). The "End Project" activity shall have an "Late Finish (LF)" constraint date equal to the contract completion date for the project, and with a zero-day duration or by using the "project must finish by" date in the scheduling software. The schedule shall have no constrained dates other than those specified in the contract. The use of artificial float constraints such as "zero free float" or "zero total float" are prohibited. There shall only be two (2) open ended activities: Start Project (or NTP) with no predecessor logic and End Project with no successor logic.

3. Early Project Completion

In the event the Construction Schedule calculates an early completion date of the last activity prior to the contract completion date, identify those activities that it intends to accelerate and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. The last activity shall have a late finish constraint equal to the contract completion date and the schedule will calculate positive float. Engineer is under no obligation to accelerate activities for which it is responsible to support a proposed early contract completion.

C. Default Progress Data Disallowed

Do not automatically update Actual Start and Finish dates with default mechanisms that may be included in the scheduling software. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process shall match those dates provided from Contractor Daily Reports. Failure of the Contractor to document the AS and AF dates on the Daily Report for every in-progress or completed activity, and failure to ensure that the data contained on the Daily Reports are the sole basis for schedule updating shall result in the disapproval of the Contractor's updated schedule and the inability of the Engineer to evaluate Contractor progress for payment purposes. Updating of the percent complete and the remaining duration of any activity shall be independent functions. Disable program features which calculate one of these parameters from the other.

D. Calculation Mode

Schedule calculations shall retain the logic between predecessors and successors even when the successor activity starts and the predecessor activity has not finished. Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") will not be allowed.

E. Milestones

The schedule must include milestone activities for each significant project event including but not limited to: milestone activities for foundation/substructure construction complete; superstructure construction complete; building dry-in or enclosure complete to allow the initiation of finish activities; permanent power complete; and building systems commissioning complete, and any other major milestones identified as being required by the Engineer.

F. Horizontal Time Scale: Identify first workday of each week.

G. Scale and Spacing: Notes must be legible. Allow space for notations and future revisions.

H. Order of Listings: Order bar chart listings by phases or other approved groups of activities that are contiguous. List activities in chronological order within each phase or group.

1.6 MONTHLY SCHEDULE UPDATE

A. Status of Activities

Update information, including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete shall be subject to the approval of Engineer. As a minimum, address the following items on an activity by activity basis during each progress meeting.

B. Start and Finish Dates

Accurately show the status of the AS and/or AF dates for each activity currently in-progress or completed since the last update. Engineer may allow an AF date to be assigned with the percent complete less than 100 percent to account for the value of work remaining but not restraining successor activities. Only assign AS dates when actual progress occurs on an activity.

C. Remaining Duration

Update the estimated RD for all incomplete activities independent of Percent Complete. Remaining Durations may exceed the activity Original Duration (OD) or may exceed the activity's prior update RD if Engineer considers the current OD or RD to be understated based on current progress, insufficient work crews actually manning the job, unrealistic OD or deficiencies that must be corrected that restrain successor activities.

D. Percent Complete

All activities in the schedule shall be assigned a Percent Complete Type of Physical Percent Complete except for activities that are dependent on time (i.e. Level of Effort Activities, Procurement, Curing, etc.). Update the percent complete for each activity

started, based on the realistic assessment of earned value. Activities which are complete with the exception of remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete with Engineer approval.

E. Schedule Changes

1. Other changes required due to delays in completion of any activity or group of activities include: 1) delays beyond the Contractor's control, such as strikes and Excusable Delays as define in the General Conditions. 2) delays encountered due to submittals, Engineer Activities, deliveries or work stoppages which make re-planning the work necessary. 3) Changes required to correct a schedule that does not represent the actual or planned prosecution and progress of the work.
2. Specifically identify and discuss all logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, Contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, and other changes that have been made pursuant to contract provisions. Engineer will only approve logic revisions for the purpose of keeping the schedule valid in terms of its usefulness in calculating a realistic completion date, correcting erroneous logic ties, and accurately sequencing the work.
3. Contractor shall submit to Engineer for acceptance proposed adjustments in the Construction Schedule that will not result in changing the Contract Times. Proposed adjustments in the Construction Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 11 of the General Conditions.
4. If, in the opinion of Engineer, Contractor falls behind the accepted Construction Schedule due to actions or neglect of Contractor or Contractor's agents, servants, employees, officers, subcontractors, directors, or any party contracting to perform part or all of the Work or to supply any equipment or materials, Contractor shall take steps, including, but not limited to, expediting delivery of equipment or materials and increasing the number of personnel, shifts, and/or overtime operations, increasing the days of work, and/or increasing the amount of construction equipment until such time as the Work is back on schedule. Contractor shall also submit for review not later than the time of submittal of the next request for partial payment, such supplementary schedule or schedules as may be necessary to demonstrate the manner in which the acceptable rate of progress will be regained, all without additional cost to Owner.

F. Data date used in updating monthly Construction Schedule shall be the same date as used in monthly Payment Application. Monthly update of Construction Schedule is required for monthly Payment Application to be processed for payment.

G. Schedule Update at Monthly Progress Meetings

1. Provide a Gantt chart produced by the scheduling software, organized by Total Float and Sorted by Early Start Date, and a two week "look-ahead" schedule by filtering all schedule activities to show only current ongoing activities and activities schedule to start during the upcoming two weeks, organized by Work Area Code (AREA) and sorted by Early Start Date. The Contractor will provide the schedule in *.XER format prior to the meeting, and will be prepared to facilitate discussions regarding the schedule.
2. Contractor represents and warrants, as a material inducement to Owner to enter into the Agreement, that under no circumstances will it assert that any "look-ahead" schedule, progress schedule or schedule update prepared or published by or on behalf of Contractor, or the review by Engineer of any such "look-ahead" schedule or progress schedule, actual Work progress schedule, or schedule update, constitutes an extension of the Contract Time or a waiver by Engineer of its right to enforce the Contract Time, or in any way waive enforcement of the Contract Time and Milestones set forth in the Agreement.

1.7 SCHEDULE REPORTS

- A. Schedule Reports: The format, filtering, organizing and sorting for each schedule report shall be as directed by the Engineer. Typically reports shall contain: Activity ID, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Physical Percent Complete. The following lists typical reports that will be requested. One or all these reports may be requested for each schedule submission.
 1. Activity Report: A list of all activities sorted according to activity number.
 2. Logic Report: A list of detailed predecessor and successor activities for every activity in ascending order by activity number.
 3. Total Float Report: A list of all incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.
 4. Cash Flow Curve Report: Prepare and submit graphic or tabular display of estimated monthly billings (i.e. a cash flow curve for the Work) with the first schedule submittal. This information is not required in monthly updates, unless significant changes in work require re-submittal of schedule for review. Display shall allocate units indicated in bid schedule or Schedule of Values to Construction Schedule activities. Weighted allocations are acceptable, where appropriate. Dollar value associated with each allocated unit will be spread across the duration of that activity on a monthly basis. Total for each month and cumulative total will be indicated. These monthly forecasts are only for

Engineer's planning purposes. Monthly payments for actual work completed will be made in accordance with the General Conditions.

5. Submit electronic Schedule Reports (*.PDF format) to the WHCRWA Project Management Information System Software, Orion.

1.8 NARRATIVE REPORT

- A. Provide a Narrative Report that provides the information outlined in this Section. The narrative report is expected to communicate to Engineer, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis. Identify and explain why any activities that, based on their calculated late dates, should have either started or finished during the update period but did not.
- B. Narrative schedule report shall list activities started this month, activities completed this month, activities continued this month, activities scheduled to start or complete next month, problems encountered this month, and actions taken to solve these problems.
- C. Narrative schedule report shall describe changes made to Construction Schedule logic (i.e. changes in predecessors and lags), activities added to schedule, activities deleted from schedule, any other changes made to the schedule other than addition of actual start dates and actual finish dates and changes of data date and remaining durations for re-calculation of mathematical analysis.
- D. Discuss any activity that affects the public (such as phases of traffic control), interaction with specific forces of the Authority (such as valve operation) or other associated contractors.
- E. Discuss the critical path and near critical path(s), any loss in total float on this path, and the cause for reduction in total float. If delays have been realized, discuss the Contractor's plan to minimize or eliminate their impacts, and meet the contractual completion dates.
- F. Provide a narrative report to describe progress revisions:
 1. Major changes in scope.
 2. Revised projections in progress, completion, or changes in activity duration.
 3. Other identifiable changes.
 4. Problem areas, anticipated delays, and the impact on schedule.
 5. Corrective action recommended and its effect.
 6. Effect of changes on schedules or other contractors.
 7. Product delivery lead times.
- G. Submit electronic Narrative Schedule Report (in the form of approved word processor or *.PDF format) to the WHCRWA Project Management Information System Software,

Orion.

1.9 NETWORK DIAGRAMS

A. The network diagram is required for the initial construction schedule submittal. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Engineer will use, but is not limited to, the following conditions to review compliance with this paragraph:

1. Continuous Flow: Diagrams shall show a continuous flow from left to right with no arrows from right to left. Show the activity number, description, duration, and estimated earned value on the diagram.
2. Project Milestone Dates: Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.
3. Critical Path: Clearly show the critical path.
4. Banding: Organize activities as directed to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

1.10 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either Owner or the Contractor.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION Not Used

END OF SECTION

Section 01330

SUBMITTAL PROCEDURES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

A. Submittal procedures for:

1. Schedule of Values
2. Construction Schedules and Cash Flow Curve (billing forecast).
3. Shop Drawings, Product Data and Samples
4. Operations and Maintenance (O&M) Data
5. Manufacturer's Certificates
6. Construction Photographs
7. Project Record Documents and monthly certification.
8. Video Tapes
9. Design Mixes

1.2 SUBMITTAL PROCEDURES

A. Scheduling and Handling:

1. Submit shop drawings, data, and samples for related components electronically using WHCRWA FTP site as required by Engineer.
 - a. Authority requires the use of WHCRWA FTP site to track the progress of West Harris County Regional Water Authority Contracts.
 - b. All project documentation and correspondence, including Submittals, Request for Information (RFI), Request for Proposal (RFP), Change Orders, etc are to be transmitted electronically using WHCRWA FTP site or approved equal. Documents requiring original signature will be input into WHCRWA FTP site. The signed original are to be received by

Engineer on the same day document is logged in electronically in WHCRWA FTP site. Documents received that are not input into WHCRWA FTP site may not be accepted by Engineer.

- c. Documents are to be submitted electronically in *.PDF format. No printed copies of submittal will be accepted for review unless original signature is required.
 - d. Samples accompanying submittals and documentation are to be received by Engineer on the same day submittal is logged in electronically.
- 2. Schedule submittals well in advance of need for construction Products. Allow time for delivery of Products after submittal approval.
 - 3. Develop submittal schedule that allows sufficient time for initial review, correction, resubmission and final review of all submittals. Allow a minimum of 30 days for initial review. Engineer will review and return submittals to Contractor as expeditiously as possible but time required for review will vary depending on complexity and quantity of data submitted.
 - 4. Engineer's review of submittals covers only general conformity to Drawings, Specifications and dimensions that affect layout. Contractor is responsible for quantity determination. No quantities will be verified by Engineer. Contractor is responsible for errors, omissions or deviations from Contract requirements; review of submittals does not relieve Contractor from the obligation to furnish required items in accordance with Drawings and Specifications.
 - 5. Submit all submittals electronically using WHCRWA FTP site unless otherwise specified in following paragraphs or Specifications.
 - 6. Revise and resubmit submittals as required. Identify all changes made since previous submittal.
 - 7. Assume risk for fabricated Products delivered prior to approval. Do not incorporate Products into the Work, or include payment for Products in periodic progress payments, until approved by Engineer.

B. Transmittal Form and Numbering:

- 1. Transmit each submittal to Engineer with Transmittal letter which includes:
 - a. Date and submittal number
 - b. Project title and number

- c. Names of Contractor, Subcontractor, Supplier and manufacturer
 - d. Identification of Product being supplied
 - e. Location of where Product is to be Installed
 - f. Applicable Specification section number
 2. Identify deviations from Contract documents clouding submittal drawings. Itemize and detail on separate 8-1/2 by 11-inch sheets entitled "DEVIATIONS FOR_____." When no deviations exist, submit a sheet stating no deviations exist.
 3. Have design deviations signed and sealed by an appropriate design professional, registered in the State of Texas.
 4. Sequentially number transmittal letters beginning with number one. Use original number for resubmittals with an alphabetic suffix (i.e., 2A for the first resubmittal of submittal 2, or 15C for third resubmittal of submittal 15, etc.). Show only one type of work or Product on each submittal. Mixed submittals will not be accepted.
- C. Contractor's Stamp:
1. Apply Contractor's Stamp certifying that the items have been reviewed in detail by Contractor and that they comply with Contract requirements, except as noted by requested variances.
 2. As a minimum, Contractor's Stamp shall include:
 - a. Contractor's name
 - b. Job number
 - c. Submittal number
 - d. Certification statement Contractor has reviewed submittal and it is in compliance with the Contract
 - e. Signature line for Contractor
- D. Submittals will be returned with one of the following Responses:
1. "ACKNOWLEDGE RECEIPT" when no response and resubmittal is required.

2. "NO EXCEPTION" when sufficient information has supplied to determine that item described is accepted and that no resubmittal is required.
3. "EXCEPTIONS AS NOTED" when sufficient information has been supplied to determine that item will be acceptable subject to changes, or exceptions, which will be clearly stated. When exceptions require additional changes, the changes must be submitted for approval. Resubmittal is not required when exceptions require no further changes.
4. "REJECTED-RESUBMIT" when submittal does not contain sufficient information, or when information provided does not meet Contract requirements. Additional data or details requested by Engineer must be submitted to obtain approval.

1.3 MANUFACTURER'S CERTIFICATES

- A. When required by Specification sections, submit manufacturers' certificate of compliance for review by Engineer.
- B. Place Contractor's Stamp on front of certification.
- C. Submit supporting reference data, affidavits, and certifications as appropriate.
- D. Product certificates may be recent or from previous test results, but must be acceptable to Engineer.

1.4 DESIGN MIXES

- A. When required by Specification sections, submit design mixes for review.
- B. Place Contractor's Stamp, as specified in this section, on the front of each design mix.
- C. Mark each mix to identify proportions, gradations, and additives for each class and type of mix submitted. Include applicable test results from samples for each mix. Perform tests and certifications within 12 months of the date of the submittal.
- D. Maintain copies of approved mixes at mixing plant.

1.5 CHANGES TO CONTRACT

- A. Changes to Contract may be initiated by completing a Request for Information form. Engineer will provide a response to Contractor by completing the form and returning it to Contractor.
 1. If Contractor agrees that the response will result in no increase in cost or time, a

Minor Change in the Work will be issued by Engineer.

2. If Contractor and Engineer agree that an increase in time or cost is warranted, Engineer will forward the Request for Proposal for negotiation of a Change Order.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01340

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Methods, schedules, and processes to be followed for Shop Drawings, Product Data and Sample submittals.

1.2 REQUIREMENT

- A. Submit Shop Drawings, Product Data and Samples as required by the General Conditions of the Construction Contract and Specification sections, using procedures specified in Section 01330 - Submittal Procedures and the requirements of this Section.
- B. Shop Drawings, Product Data and Samples are not considered Contract documents.

1.3 SHOP DRAWING/SUBMITTAL SCHEDULE

- A. Submit a separate Shop Drawing submittal schedule at same time the Construction Schedule is submitted. List Products for which Shop Drawings and other submittals are required in the order that they appear in Specifications. Include Product Data and Sample submittals in the schedule. Payment Applications or Certificates for Payment will not be processed until Engineer has approved the Shop Drawing submittal schedule.

1.4 SHOP DRAWINGS

- A. Submit electronic copy of Shop Drawings and product data in *.PDF format using WHCRWA FTP site. Review and sign Shop Drawings indicating compliance with the Contract.
- B. Place Contractor's Stamp on each drawing as described in Section 01330 - Submittal Procedures.
- C. Show the following accurately and distinctly:
 - 1. Field and erection dimensions;
 - 2. Arrangement and section views;
 - 3. Relation to adjacent materials or structure, including complete information for making connections between the Work and work under other contracts;

4. Types of Products and finishes;
 5. Parts list and descriptions;
 6. Assembly drawings of equipment components and accessories showing respective positions and relationships to the complete equipment package;
 7. Identify details by referencing drawing sheet and detail numbers, schedule or room numbers as shown on the Contract drawings, where necessary for clarity.
- D. Scale drawings to provide a true representation of the specific equipment or item Furnished.
- E. Coordinate and submit components, necessary for Engineer to adequately review submittal, as a complete package. Reproduction of the Drawings for use in Shop Drawings is not allowed.
- F. For major changes to original documents, submit Computer-Aided Design (CAD) drawings using WHCRWA FTP site.

1.5 PRODUCT DATA

- A. Submit Product Data for review as required in Specifications.
- B. Place Contractor's stamp, on each data item submitted, as described in Section 01330 - Submittal Procedures.
- C. Mark each copy to identify applicable Products, models, and options to be used in the Work. Where required by Specifications, supplement manufacturers' standard data to provide information unique to the Work.
- D. Give manufacturers, trade name, model or catalog designation and applicable reference standard for Products specified only by reference standards.
- E. Pre-approved and Pre-qualified Products.
1. For "Pre-approved", " Products named in the Authority standard products list, provide an appropriate list designation, as described in Section 01630 - Product Substitution Procedures, within 30 days after Notice to Proceed.
 2. For Products proposed as alternates to "Pre-approved" products, provide information required to demonstrate that the proposed Products meet the level of quality and performance criteria of the "Pre-approved" product.

1.6 SAMPLES

- A. Submit Samples for review as required by Specifications. Have Samples reviewed and signed by a Registered Professional.
- B. Place Contractor's stamp on each Sample or firmly attach a sheet of paper with Contractor's stamp, as described in Section 01330 - Submittal Procedures.
- C. Submit the number of Samples specified in Specifications; Engineer will retain one.
- D. Reviewed Samples that may be used in the Work are identified in Specifications.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

SECTION 01351

ENVIRONMENTAL SAFETY AND WORKER PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

Environmental Safety and Worker Protection including monitoring emissions and exposure to workers and providing an appropriate response. The role of the Certified Industrial Hygienist (CIH) is also defined.

1.2 MEASUREMENT AND PAYMENT

No separate measurement and payment for work performed under this Section. The Contractor shall include the cost for this work in the contract bid price for work of which this is a component part.

1.3 REFERENCES

The following is a list of applicable requirements to this project. It is not intended to be a complete listing of all laws and regulations to which the Contractor must comply.

A. Code of Federal Regulations

1. 29 CFR 1910, "Occupational Safety and Health Standards".
 - a. 29 CFR 1910.146 "Permit-required confined spaces".
2. 29 CFR 1926, "Safety and Health Regulations for Construction" (Construction Industry Standards).
 - a. 29 CFR 1926.33 "Access to Employee Exposure and Medical Records".
 - b. 29 CFR 1926.51, "Sanitation Standard".
 - c. 29 CFR 1926.59, "Hazard Communication".
 - d. 29 CFR 1926.62, "Lead".
 - d. 29 CFR 1926.103 "Respiratory Protection".
3. 40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards"
 - a. 40 CFR 50 Appendix B, "Reference Method for the Determination of

Suspended Particulate Matter in the Atmosphere (High Volume Method)".

- b. 40 CFR 50 Appendix G, "Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air".
- 4. 40 CFR 58, "Ambient Air Quality Surveillance".
- 5. 40 CFR 60 Appendix A, "Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Fires".
- 6. 40 CFR 117, "Determination of Reportable Quantities for Hazardous Substances".
- 7. 40 CFR 122, "Administered Permit Program: The National Pollutant Discharge Elimination System".
- B. National Institute for Occupational Health and Safety NIOSH Method 7082, "Lead" (or equivalent).
- C. American Society for Testing and Materials

ASTM D3335, "Test Method for Low Concentrations for Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy."
- D. EPA (Environmental Protection Agency) Publications
 - 1. SW-846, "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods".
 - 2. EPA Method 3050, "Acid Digestion of Sediments, Sludges, and Soils".
- E. SSPC Guide 6, "Guide for Containing Debris Generated During Paint Removal Operations".
- F. SSPC Guide 7, "Guide for the Disposal of Lead Contaminated Surface Preparation Debris".
- G. SSPC Publication 91-18, "Industrial Lead Paint Removal Handbook".
- H. Texas Commission on Environmental Quality
 - 1. Texas Administrative Code (TAC) 30, Chapter 101, "General Rules".
 - 2. Texas Administrative Code (TAC) 30, Chapter 111, "Control of Air Pollution from Visible Emissions and Particulate Matter".
 - 3. Texas Administrative Code (TAC) 30, Chapter 290, "Water Hygiene".
 - 4. Texas Administrative Code (TAC) 30, Chapter 307, "Surface Water Quality Standards".

5. Texas Administrative Code (TAC) 30, Chapter 309, "Effluent Limitations".
6. Texas Administrative Code (TAC) 30, Chapter 335, "Industrial Solid Waste and Municipal Hazardous Waste".

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 – Submittal Procedures.
- B. Submittals shall conform to appropriate codes for regulatory requirements.

1.5 DEFINITION

- A. Acceptance Criteria: Minimum standards for the content of programs, plans, procedures, and designs required by this specification for the performance of this project. Acceptance criteria will be the basis for judging the responsiveness of Contractors' programs and will also be used as a basis for suspending work, if necessary.
- B. Action Level: Employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) calculated as an eight hour time-weighted average (TWA).
- C. CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act; commonly called Superfund. Federal laws addressing the clean up of hazardous waste sites. Amended in 1986 by Superfund Amendments and Re- Authorization Act (SARA). EPA implementing regulations are contained in 40 CFR 300-373.
- D. Competent Person: One who is capable of identifying existing and predictable lead hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to eliminate them.
- E. Containment System: An enclosure built around lead paint removal areas designed to contain lead paint debris and prevent emissions to the environment.
- F. Dust Collection: Mechanical ventilation system designed specifically for the containment, capture, and removal of airborne particulate from the containment. Dust collection systems shall include ductwork, plenums and/or hoppers, and dust collector(s) for the removal of leaded paint dust from the air stream prior to discharging to the atmosphere.
- G. Emission: A release of material to the air, water, or ground.
- H. Entry/Exit Airlock: An isolated enclosure located at the entrance of the containment in which the workers remove contaminated dust and debris from their work clothes.
- I. EPA: The US. Environmental Protection Agency. Regulations are contained in Title 40 of the Code of Federal Regulations (40 CFR).

- J. Hazardous Waste (lead paint debris): Waste that is classified as hazardous due to its concentrations of regulated hazardous substances. Paint debris is classified as hazardous waste if, after testing by the Toxicity Characteristic Leaching Procedure (TCLP), the leachate contains any of the 8 metals or other substances in concentrations at or above limits established in 40 CFR 261.
- K. HEPA: A high efficiency particulate filter (HEPA) that is 99.97% efficient against particles of 0.3 microns in size or larger.
- L. Lead Containing Dust and Debris: Dust and debris generated during the project which contains lead in any amount, including but not limited to pulverized paint, spent abrasive, filters (wet and dry), and containment materials upon which lead is still present.
- M. NIOSH: National Institute of Occupational Safety and Health.
- N. OSHA: Occupational Safety and Health Administration. Standards are contained in Title 29 of the Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 29 CFR 1926).
- O. Owner: The West Harris County Regional Water Authority
- P. PEL: Permissible Exposure Limit. An employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 50 µg/m³ over an 8 hour TWA.
- Q. POTW: Publicly Owned Treatment Works
- R. RCRA: Resource Conservation and Recovery Act. Federal law pertaining to hazardous waste management. EPA implementing regulations are contained in 40 CFR 240-280.
- S. Regulated Area: Area established by the Contractor to demarcate the zone(s) beyond which airborne concentrations of lead do not exceed the Action Level.
- T. SSPC: Society for Protective Coatings. An independent, non-profit organization of engineers, technical specialists, and Contractors whose goal is research and development of new coatings and methods for removal, application, and disposal of existing coatings on industrial structures.
- U. Tarpaulins: Flexible fabric, vinyl, plastic or canvas cover sheets, impenetrable to dust, wind, and water, used to enclose the cable and/or scaffold support system comprising the containment enclosure.
- V. TCLP: Toxicity Characteristic Leaching Procedure. Laboratory tests conducted on wastes that determine the amount of hazardous materials that leach out into a test solution. The test is intended to simulate the properties of water as it leaches through a solid waste landfill. TCLP testing is defined in 40 CFR 261, Appendix II.
- W. TSP: Total Suspended Particulate

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

- A. The Contractor is to supply materials and equipment to insure the safety and protection of workers and the environment in accordance with these specifications.

PART 3 EXECUTION

3.1 ENVIRONMENTAL PROTECTION AND MONITORING

NOTE: Section 09971 "Painting and Protective Coatings", 2.04 "Containment System" specifically identifies containment system requirements.

- A. Protection of Ambient Air: Visible emissions are to be controlled to meet, as a minimum, TAC 30 Chapter 111, "Control of Air Pollution from Visible Emissions and Particulate Matter" requirements and SSPC-Guide 6I (CON), Level 1 Emissions. Air monitoring and analysis may be performed by the Authority during abrasive blast cleaning operations. Such monitoring will be in accordance with 40 CFR 50, Appendix B, "Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere" and/or 40 CFR 50, Appendix G, "Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air". The limits for downwind pollutant concentrations allowed during blasting operations are as follows:

PM-10: 450 micrograms/cubic meter/ 8 hr.. (40 CFR 50.6)

Lead (Pb): 13.5 micrograms/cubic meter/8 hr.. (40 CFR 50.12)

Visible emissions and/or monitored emissions for PM-10 and TSP lead in excess of the above levels shall be cause for shut down of the project until corrections to control/ containment system or paint removal/ surface preparation operations are made to comply with these requirements.

- B. Protection of Surface and Storm Water: The Contractor shall take all necessary precautions to ensure lead contaminants do not enter surface waters or storm water drainage systems.
1. The Contractor shall protect the area around ditches and drainage inlets. Daily verification of proper protection to minimize the potential contaminants reaching the drainage system shall be performed.
 2. The Contractor shall collect all potentially contaminated process waters for testing and, as appropriate, treatment. Process water from pressure washing, wet abrasive blast cleaning or hygiene facilities shall not be discharged to drainage systems or surface waters.

3. The Contractor may remove lead or other heavy metals from such waters through filtration, ion exchange or other approved means. Following treatment, water samples must be tested prior to disposal. Discharge to sanitary sewer lines requires authorization, in writing, from a POTW.
- C. Protection of Soil and Grounds: The Contractor shall protect the soil around the structure to ensure that the soil does not become contaminated. Where lead is present in the coatings to be removed, as indicated in Section 02136 "Waste Material Handling and Disposal", the Contractor shall provide for the sampling and analysis of soil samples for total lead content.
1. Sampling and analysis shall be performed prior to commencement of paint removal operations to establish a background "base level". Soil samples shall be taken 3 feet from the base of the tank(s), at a distance of 6-10 feet beyond the proposed containment structure and at the propertyline.
 2. Samples from each area shall be taken in a minimum of four directions, at circular increments of 90°, one of which shall include the direction of prevailing wind. Samples shall also be obtained, at the direction of the Design Professional of Record or Engineer, at the closest points of public access (i.e. housing, park, school).
 3. The soil sampling procedure shall be as outlined in SSPC Guide 6 Section 5.5.5. Each sampling point shall be sufficiently identified on a site map to allow return to the exact location upon project completion.
 4. Each sample shall be split in two portions, one for immediate analysis and the other sealed, preserved and furnished to the Engineer. The samples shall be analyzed in accordance with EPA Method 3050, "Acid Digestion of Sediments, Sludges and Soils", and shall be performed by a qualified laboratory approved by the Engineer.
 5. Samples shall be obtained at the completion of work (post-construction samples) from all locations from which pre-construction samples were obtained. Samples shall be collected, handled and tested in the same manner as described above.
 6. Upon completion of the work, soils found to be contaminated with lead in greater quantity than found in the background "base level", established at the start of the work, shall be removed by the Contractor to the depth necessary to achieve a lead content equivalent to, or below, the pre- construction back ground levels. Disposal shall be in accordance with applicable regulations.
 7. The Contractor shall replace in-kind (i.e., topsoil, structural fill, etc.) with an equivalent amount of non-contaminated soil, compact in place and grade to pre-existing conditions. The Contractor shall also replace in-kind any surface improvements, such as grass, shrubs, etc. that were damaged or destroyed by the work. The soil removal, replacement and related work is to be performed by the Contractor at no

additional cost to the Owner.

3.2 WORKER PROTECTION

- A. The Contractor shall develop a written Compliance Program to establish and implement practices and procedures for assuring that no employee is exposed to lead at concentrations greater than 50 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$), the OSHA permissible exposure limit (PEL). This program is in addition to other OSHA hazard communication and safety and health requirements of the project, and shall be revised and updated at least every six months.
1. The program shall establish methods for complying with this specification and the OSHA Construction Industry Lead Standard, 29 CFR 1926.62(e)(2)(ii). The Federal regulation is referred to as the "Lead Standard" for the purpose of this specification.
 2. The program shall apply to all Contractor employees associated with lead on the project, and to subcontractors working under the direct control of the Contractor who are associated with lead on the project.
 3. The program shall assign the specific responsibility for implementation and enforcement of the program to the Contractors' company management. The Contractor's Competent Person(s) shall be identified, by name, and qualifications submitted. The Competent Person shall be on-site during any operations which involve the removal, handling or disturbing of lead containing materials.
 4. The program shall contain a description of each activity in which lead is emitted (e.g. equipment used, material involved, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices).
 5. The program shall contain a report of the technology considered in meeting the PEL and air monitoring data which documents the source of lead emissions.
 6. The program shall contain a work practice program which includes items required in the lead standard such as protective clothing and equipment, housekeeping, and hygiene facilities and practices.
- B. Exposure Monitoring: The Contractor shall be responsible for conducting and reporting worker exposure assessments in accordance with 29 CFR 1926.62.
1. Representative personal air samples shall be collected at the beginning of the lead removal work to determine employee lead exposures. Tasks involving potential lead exposure include, but are not limited to, paint removal operations, clean-up, and debris handling operations. Full shift (at least 7 hours) air samples shall be collected for each job classification in the exposure area. The range of exposures for lead removal and cleanup activities shall be determined.

2. During the initial monitoring, workers performing the following activities (or equivalent) shall be protected to the anticipated exposure levels which are dictated by the lead standard:
 - a. $500 \mu\text{g}/\text{m}^3$: Manual demolition of structures containing lead- containing coatings or paint (e.g., dry wall), manual scraping, manual sanding, heat gun applications, power tool cleaning with dust collection systems, and spray painting with leadpaint.
 - b. $2,500 \mu\text{g}/\text{m}^3$: Using lead-containing mortar, lead burning, or conducting the following activities where lead-containing coatings or paint are present: rivet busting, power tool cleaning without dust collection systems, clean-up activities where dry expendable abrasives are used, and the movement and removal of abrasive blasting enclosures.
 - c. More than $2,500 \mu\text{g}/\text{m}^3$: Activities involving lead containing coatings or paint on structures disturbed by abrasive blasting, welding, cutting, and torch burning.
3. Protection requires compliance with the necessary respiratory protection, personal protective clothing and equipment, change areas and washing facilities, blood lead and zinc protoporphyrin monitoring, and employee training. The protection measures shall be modified, as necessary, after the exposure results are received.
4. Where initial monitoring indicates that lead exposures are below the Action Level, and where work activities and conditions remain the same as at the time of initial sampling, additional monitoring need not be repeated for that work activity.
5. Where the initial monitoring of a given work activity indicates that lead exposures are at or above the Action Level, additional exposure monitoring shall be conducted monthly. The monthly monitoring is more frequent than frequencies established in the lead standard which are at least every 6 months if above the Action Level, but below the PEL, or every 3 months if above the PEL.
6. All air samples shall be collected and analyzed according to NIOSH Method 7082, or equivalent. All samples shall be analyzed by laboratories accredited by the American Industrial Hygiene Association for metals analysis.
7. All exposed employees shall be notified in writing of the monitoring results within five (5) days after receiving the results.
8. The Action Level for airborne lead exposure is $30 \mu\text{g}/\text{m}^3$, as an 8-hour time weighted average (TWA) concentration, without regard to the use of respirators. Whenever workers' airborne lead exposures exceed the Action Level, the Contractor shall implement the following:

- a. Periodic Exposure Monitoring
 - b. Employee Information and Training
 - c. Employee Medical Surveillance and Medical Removal Protection
 - d. Housekeeping
 - e. Record keeping
 - f. Signs and Regulated Areas
- 9. The Permissible Exposure Limit (PEL) for airborne lead exposure is $50 \mu\text{g}/\text{m}^3$, as an 8-hour TWA concentration. When the work area contains airborne lead levels above the PEL the Contractor shall implement the following in addition to those items listed in 3.2.B.8 of this section:
 - a. Compliance Program
 - b. Respiratory Protection
 - c. Protective Clothing and Equipment
 - d. Hygiene Facilities and Practices
- C. Respiratory Protection: After feasible engineering controls and work practices have been implemented, respiratory protection shall be used to maintain employees' lead exposures below the PEL.
 - 1. Respirators shall be worn by all employees, other Contractors, representatives, or observers who enter regulated areas.
 - 2. The Contractor shall develop a written Respiratory Protection Program in compliance with 29 CFR 1910.134, paragraphs (b), (d), (e), and (f), and the lead standard. The program shall address the selection, use, maintenance, and inspection of respirators, and qualifications for respirator users.
- D. Protective Clothing and Equipment: The Contractor shall provide protective clothing and equipment and ensure they are worn by all employees whose lead exposures exceed the PEL, or who enter regulated areas.
 - 1. Protective clothing shall include washable and/or disposable full body coveralls, gloves, foot coverings, and hoods. Other protective equipment shall include face shields, hard hats, eye protection, and hearing protection as appropriate.

2. Disposable protective clothing shall be used for no more than one work day. Such clothing may have to be disposed of as hazardous waste.
 3. Reusable protective equipment shall be cleaned or replaced weekly if exposure levels are less than $200 \mu\text{g}/\text{m}^3$, or daily if the exposure levels are greater than or equal to $200 \mu\text{g}/\text{m}^3$.
 4. Clothing shall not be removed or "cleaned" by any means which could reintroduce the lead dust into the ambient air. This includes brushing, shaking, and blowing. Vacuums equipped with HEPA filters shall be used for this purpose.
 5. Reusable coveralls shall be collected at the end of each work day in closed containers. The containers shall be labeled in accordance with the requirements of 29 CFR 1926.62(g)(2)(vii). Contaminated clothing shall be cleaned in accordance with all applicable Federal, State, or local regulations pertaining to lead-contaminated laundry and water discharge. Laundries shall be informed that the clothing contains lead. If the clothing is washed on site, the discharge water shall be filtered, containerized, and arrangements made with the local POTW or other approved means of proper disposal.
 6. Protective clothing and equipment shall be removed in the contaminated section of the change area and shall not be worn into any clean areas.
 7. The Contractor shall provide the necessary clothing and equipment for use by the Owner and its designated representatives.
- E. Housekeeping: Accumulations of lead-containing dust and debris generated by work activities shall be removed and cleaned daily.
1. All persons doing the cleanup shall be trained in performing lead activities, respirator qualified, and participate in the medical surveillance program. Respirators and protective clothing shall be worn by all persons doing the cleanup.
 2. Compressed air may be used for housekeeping if used within containment and in conjunction with a ventilation system designed to capture the dust. Otherwise, HEPA-filtered vacuum cleaners shall be employed.
 3. All lead-containing dust and debris shall be collected in sealed containers. The waste shall be tested to determine whether it will be disposed of as hazardous waste.
- F. Personal Hygiene Facilities and Practices
1. Clean change areas shall be provided when employees' lead exposures exceed the PEL. The change areas shall be equipped with storage facilities for street clothing and a separate area for the removal and storage of lead-contaminated clothing and

equipment. They shall be designed and used so that contamination of street clothing does not occur. Employees shall not leave the project site wearing any clothing worn while performing lead activities. Airborne lead exposures in the change area shall be maintained below the Action Level.

2. Shower facilities shall be provided whenever employees' lead exposures exceed the PEL. Shower facilities shall comply with OSHA Sanitation Standard, 29 CFR 1929.51. All employees whose lead exposures exceed the PEL shall shower at the end of each work shift or before leaving the project area. The shower facilities shall be made available for use by the Owner and its representatives, such as inspectors or observers.
3. Arrangements shall be made with the local POTW for the proper disposal of the shower and wash water after filtration (e.g., through a three stage 100, 50, and 5 micron filtering system), ion exchange, or other approved treatment technology.
4. Clean lunch areas shall be provided for all employees whose lead exposures exceed the PEL. Employees shall remove or clean (by vacuuming) their protective clothing and wash their hands and face before entering the lunch area. Lead exposures in the lunch area shall be maintained as free as practicable from lead contamination.
5. An adequate number of clean lavatory and hand washing facilities shall be provided. These shall comply with the OSHA Sanitation Standard, 29 CFR 1929.51.
6. Eating, drinking, smoking, chewing of food or tobacco products, or the application of cosmetics shall not be permitted in any areas where the lead exposures exceed the PEL. Thorough washing of hands and face is required prior to undertaking any of these activities.

G. Medical Surveillance and Medical Removal Protection

1. All employees who are exposed to lead above the Action Level in a single day during this project shall be provided with initial and periodic medical examinations and blood lead tests as required by the lead standard. A final blood lead test shall be provided for each worker upon completion of the project, or at any time a worker's employment at the project ceases.
2. When blood lead levels over 50 µg/dl are encountered, the Contractor shall provide for the temporary removal of employees from lead exposure above the Action Level. The required medical surveillance and periodic blood lead tests shall be provided in strict accordance with the lead standard throughout the removal.
3. Employees who will be required to wear a respirator or who request one shall be provided with a respirator and the necessary medical examinations to determine their ability to wear a respirator.
4. All examinations shall be provided by the Contractor and shall be performed by or

under the direct supervision of a licensed physician.

H. Employee Information and Training

1. The Contractor shall provide lead training for all employees who are exposed to lead above the Action Level for this project.
2. The content of lead training shall include, as a minimum, those items listed in the lead standard.
3. Training shall also include hazard communication in accordance with 29 CFR 1926.59.
4. The Contractor shall notify other employers at the project site of the nature of the lead exposure work, the need to remain out of exposure areas, the warning sign and labeling system in effect, and the potential need for them to take measures to protect their employees.

I. Signs and Regulated Areas

1. The Contractor shall establish a regulated area surrounding activities where lead exposures exceed the Action Level. This includes locations where lead-containing debris is handled or transferred to storage containers.
2. The regulated area shall be demarcated by ropes, tape, walls, or containment's with caution signs posted at all accessible sides. Signs shall contain the legend:

WARNING LEAD WORK AREA
POISON
NO SMOKING OR EATING

3. The Contractor shall control access of persons into regulated areas. Access shall be limited to individuals with proper training and personal protective equipment, and medical surveillance testing.
4. All persons entering regulated areas shall wear protective clothing and respirators.
5. Eating, drinking, smoking, and chewing of food or tobacco products shall be prohibited in regulated areas and in any area where lead exposures exceed the Action Level.

- J. Record keeping: All records relating to training, medical examinations, blood lead monitoring, and exposure monitoring shall be maintained by the Contractor as required by the lead standard. All records shall be available for review by the Owner or its representative upon request.

3.3 CERTIFIED INDUSTRIAL HYGIENIST (CIH)

- A. The Contractor shall provide for the services of a Certified Industrial Hygienist (CIH) who must be certified by the American Board of Industrial Hygiene in comprehensive practice.
- B. Duties of the CIH shall be as follows:
 - 1. Conduct and/or verify training for contractor employees in accordance with 29 CFR 1926.62 (I).
 - 2. Review and approve Contractor's Written Compliance Plan for conformance to 29 CFR 1926.62(e)(2)(ii) and this Specification.
 - 3. Monitor and evaluate work weekly to assure conformance with the approved plan and that hazardous exposure is adequately controlled in accordance with worker safety and health requirements of these specifications
 - 4. Provide monthly reports of work compliance with control requirements in regards to working in a lead environment.
- C. Activities of the CIH shall include:
 - 1. Meet with Authority to discuss details of Contractor's Written Compliance Plan for lead paint removal.
 - 2. Ensure worker and area air monitoring, testing and reporting are conducted by or under the direction of the CIH.
 - 3. Furnish a detailed worker and area air monitoring schedule coordinated with Contractor's proposed production schedule.
 - 4. Directing, monitoring and inspecting lead paint removal work to ensure that the requirements of the Contract have been satisfied during the entire lead paint removal operation.
 - 5. Report results of air monitoring samples to the Engineer, signed by the CIH within 48 hours after the air samples are taken.
 - 6. The CIH shall review sampling data, collected on a day when lead paint

removal operations occur, to determine if conditions require any change in work methods. Removal work shall not continue until approval is given by the CIH.

7. The CIH shall verify in writing and submit monitoring data to verify that:
 - a. Air borne lead levels at and beyond the lead control (regulated) area were and remained less than 30 mg/m^3 of air
 - b. Contractor conformance to 29 CFR 1926.62 and Item 3.2, above
 - c. There were no visible accumulations of lead contaminated paint, dust or debris on the work site. Adjacent areas that may have become contaminated were properly cleaned and inspected.
 - d. The CIH shall verify that the work area and contractor's equipment have been adequately cleaned of lead contamination prior to demobilization from the work site.

3.4 DEMOBILIZATION

The Contractor shall not remove the lead control area, boundaries, warning signs, etc. prior to proper removal of all hazardous wastes, debris and materials from the site and the Authority's receipt and acceptance of the CIH's verification.

END OF SECTION

Section 01381

**PRE-CONSTRUCTION AND POST-CONSTRUCTION
INSPECTIONS AND VIDEO DOCUMENTATION**

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. The Work specified in this Section defines requirements for pre-construction and post-construction inspections of the ground surface and existing structures that exist in proximity to the pipeline, tunnel alignments, and shaft sites.
- B. Other areas or structures that may require inspection include additional project facilities, utility structures, commercial buildings, or residences as requested by the Authority.

1.02 RELATED SECTIONS

- A. The Work of the following Sections applies to the Work of this Section. Other Sections not referenced below shall also apply to the extent required for proper performance of this Work:
 - 1. Section 01321 – Construction Photographs and Video Recording
 - 2. Section 01385 – Vibration Monitoring
 - 3. Section 02305 – Geotechnical Instrumentation and Monitoring

1.03 MEASUREMENT AND PAYMENT

- A. Unit Prices for water main projects.
 - 1. Payment will be made for construction of this Section and related work on a lump sum basis only if included on Exhibit 1 – Contractor’s Bid. If work is not included on Exhibit 1 – Contractor’s Bid, include the cost for construction of this Section in unit price for related items.
 - 2. Include removal and replacement of surface improvements necessary for this Section construction, such as sidewalks, asphaltic or concrete pavement, base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydromulch in lump sum for shafts.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.04 DEFINITIONS

- A. Crack Gauge: A device typically used in measuring fractures in building materials such as concrete, drywall, plaster board, asphalt, stone, etc., for the purpose of recording changes in crack conditions during a nearby construction project.

- B. Areas of Possible Influence (API): The ground surface area within a 500-foot radius from the center of the shaft sites and 100 feet on each side of the centerline of the tunnel.

1.05 SYSTEM DESCRIPTION

A. Audio/Video Recording Content

1. Scope of Coverage

- a. General: The recordings shall contain coverage of all surface features located within the API. The surface features documented within the API shall include, but not be limited to, all roadways, pavements, curbs, driveways, sidewalks, culverts, headwalls, retaining walls, dams, buildings, landscaping, trees, shrubbery, and fences. Of particular concern shall be the existence or non-existence of any faults, fractures, or defects.
- b. Streets. Where construction will extend in or adjacent to a street, the full width of the API including the street right-of-way and the areas adjacent to both sides of that right-of-way shall be recorded, unless otherwise directed by the Engineer. The term street shall be understood to mean a highway, road, street, avenue, boulevard, lane, circle, alley, etc.
- c. Building Exteriors. Furnish video of all exterior surfaces of buildings within the API. Such buildings may include houses, apartments, and other structures. Coverage shall include, but not limited to, walks, visible foundations, chimney, porches, and trim. Special attention shall be given to locations where defects such as cracks are visible.

2. Video Content

- a. Project Title and General Project Location.
- b. Time and Date.
- c. Name and Side of Street.
- d. Buildings. Identified visually by house or building number, when possible, in such a manner that the progress of the taping and the proposed system may be located by reference to the buildings.
- e. Camera Position and Pipeline Stationing. During the video recordings, the camera shall be positioned to capture view of the pipeline easement width, and recording shall take place along the pipeline starting at the beginning Station and moving in ascending Station order. At key or critical locations, the camera shall be used to capture details in a 360°manner as may be required. Stationing shall be captured on the video recording by means of construction stakes or temporary signs and audio narrative. Where no stationing appears on the engineering plans,

an appropriate stationing system, acceptable to the Engineer, shall be established and utilized.

3. Audio Content: General. Accompanying each video recording shall be a corresponding and simultaneously recorded audio recording. This audio recording, exclusively containing the commentary of the camera operator, shall assist in the maintenance of viewer orientation and in any needed identification, differentiation, clarification, or objective description of the structures being shown in the video portion of the recording. The audio recording also shall be free from any conversations between the camera operator and the other production technicians.
4. Video File Identification
 - a. Video files shall be named in accordance with the requirements of Section 01321 – Construction Photographs and Video Recording.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
 1. Qualifications: Contractor shall provide qualifications and personnel pertinent to the outlined scope of work.
 - a. Inspection Consultant shall have a minimum of five (5) years of experience inspecting projects of similar type and complexity.
- B. Product Data: An example of the proposed inspection report shall be provided for review by the Resident Project Representative (RPR) and Design Professional of Record (DPOR). A sample video of a route similar to this project to verify visual and audio quality. When accepted, this video will be the standard on which quality will be based and judged.
- C. Equipment:
 1. Video Camera – A video camera with the following capabilities will be required: HD recording, zoom, capture of still footage for the production of high-resolution photographs, and recording of sound associated with the inspection narration. Contractor shall provide written documentation to comply with these requirements. Refer to Section 01321 – Construction Photographs and Video Recording for additional requirements.
 2. Crack Gauges – Crack gauges such as the Avongard or approved equal shall be used on structures within the API at critical locations.
- D. Work Plan: Provide an inspection and monitoring plan for the known areas of concern with close coordination with the RPR or DPOR.

1.07 QUALITY ASSURANCE

- A. The detailed examination of each accessible structure shall be performed under the supervision of a Professional Engineer licensed in the State of Texas.
- B. Results of the Pre-Construction and Post-Construction Inspections shall be documented and submitted in bound volumes with the seal of the responsible Professional Engineer licensed in the State of Texas on the title page.
- C. All video recording shall be completed during periods of adequate lighting and visibility. Sufficient lighting shall be available to provide proper illumination of shadowed areas, and proper exposure adjustments shall be made where required. No recording shall be completed during precipitation, mist, or fog. Under no circumstances shall any post-production editing or modification be made to the original audio/video recording files. All audio/video recordings are to be raw, unedited, and original.

PART 2 P R O D U C T S (Not Used)

PART 3 E X E C U T I O N

3.01 GENERAL

- A. All access necessary for the videotaping and inspections will require permission from the landowner or agency. This will be negotiated and scheduled by the Contractor or their assigned agent.
- B. Refer to Section 01321- Construction Photographs and Video Recording.

3.02 PRE-CONSTRUCTION INSPECTIONS

- A. Perform a detailed inspection of each accessible structure within the API at least 30 days prior to construction.
- B. Include a drawing showing exterior conditions including measurements of any signs of existing distress such as crack lengths and widths, spalled bricks, concrete, wallboard, etc.
- C. Measure and record all existing crack conditions.
 - 1. Install as directed by Engineer, RPR, or DPOR, two-dimensional plastic crack gauges, such as Avongard or approved equal, at concrete foundation cracks or other critical locations.
 - 2. Each crack gauge installation shall include a Crack Gauge Monitoring Form that records the initial position of the crosshairs and which shall be used as a baseline for measuring any subsequent crack propagation.
 - 3. The Crack Gauge Monitoring Form shall include observation data related to the crack condition including location, separation, distance, length, existing patchwork, paint weathering, plant growth and any other observations that aid

in understanding the occurrence of cracks and the determination of relative age.

4. If crack separation is observed, the Contractor shall submit a monitoring plan so as to observe and limit potential effects for acceptance by the DPOR.
5. If interior access is provided to the structure, the Contractor shall prepare a scaled drawing of each general room noting cracks in walls, spalled bricks, hanging doors, sticking windows, or other signs of existing distress, along with their relative locations.

3.03 VIDEOTAPE SURVEY FOR SHAFT SITES

- A. The Contractor shall prepare project drawings to show the API based on the criteria from Paragraph 1.04 B.
- B. The Contractor shall videotape all structures, streets, sidewalks, curbs, and paved areas to which access is provided within the API.
- C. The Contractor shall complete the pre-construction video survey no sooner than 60 days and no later than 30 days before shaft and tunnel construction begins.
- D. The Contractor shall complete the post-construction video survey no later than 30 days after substantial completion of the Project.
- E. During the inspection, the Contractor shall provide a narrative that describes the conditions encountered within the API.

3.04 VIDEOTAPE SURVEY FOR OTHER AREAS

- A. Contractor shall provide Pre- and Post- Construction Video Documentation for other areas not included in the Videotape Survey for the shaft sites. These areas shall include those other areas which might be affected by construction operations. Under no circumstances shall construction begin until the Authority has received and accepted the audio/video recording (Pre-Construction Video). These video files will be used for reference during restoration, and as a documentation record of pre-existing conditions, should disputes or litigation arise. The Contractor shall produce a second audio/video recording (Post-Construction Video) documenting these same areas after completion of all construction activities.
- B. Continuous narrative updates of this information, plus ample description of other pertinent features, shall be given throughout the recording sequence. Such audio and video records shall include, but not be limited to, conditions of existing pavement, curbs, sidewalks, driveways, culverts, ditches, mailboxes, fences, shrubs, and landscaping, water cleanouts, water meters, condition of major structural features on residences and commercial buildings, plus signs, retaining walls, head-walls, general terrain, etc.

The Contractor shall coordinate with the owner or their agent/representative at the time of entry from the owners of private property prior to entering thereon for the

purpose of videotaping. Residences and commercial buildings shall be visually identified, including street address numbers or other specific identification.

- C. RPR will accompany the Pre- and Post- Construction Inspector during the recording sessions, to assist with locating the proposed shaft sites and adjacent areas of potential construction activity, plus identification of items and conditions which are to be recorded.

The Contractor shall notify the Engineer and RPR at least two (2) weeks in advance of the date of the intended video recordings. The construction limits (permanent and temporary easements) shall be identified on the Contractor's Work Plan on suitable base maps accepted by the Engineer and RPR, prior to the production of audio/video recordings. A log sheet (spreadsheet file) showing the recording sequences shall be maintained by the Pre- and Post- Construction Inspector, and the log sheet shall list the date for each sequence.

Where appropriate, and if approved by owners of private property, the Contractor shall physically mark areas of concern, including installation of crack gauges for monitoring purposes.

END OF SECTION

Section 01410

TPDES REQUIREMENTS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Documentation to be prepared and signed by Contractor/Operator before conducting construction operations, in accordance with the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit Number TXR150000 issued February 8, 2018 (the Construction General Permit).
- B. Implementation, maintenance inspection, and termination of storm water pollution prevention control measures including, but not limited to, erosion and sediment controls, storm water management plans, waste collection and disposal, off-site vehicle tracking, and other appropriate practices shown on the Drawings or specified elsewhere in the Contract.
- C. Review of the Storm Water Pollution Prevention Plan (SWP3) implementation in a meeting with Engineer prior to start of construction.

1.2 DEFINITIONS

- A. Commencement of Construction Activities: The initial disturbance of soils resulting from activities such as clearing, grading, and excavation activities, as well as other construction related activities (e.g., stock piling of fill material, demolition).
- B. Large Construction Activity Project that:
 - 1. disturbs five acres or more, or
 - 2. disturbs less than five acres but is part of a larger common plan of development that will disturb five acres or more of land.
- C. Small Construction Activity Project that:
 - 1. disturbs one or more acres but less than five acres, or
 - 2. disturbs less than one acre but is part of a larger common plan of development that will ultimately disturb one or more acres but less than five acres.
- D. TPDES Operator:

Operator - The person or persons associated with a large or small construction activity that is either a primary or secondary as defined below:

Primary Operator – the person or persons associated with a large or small construction activity that meets either of the following two criteria:

- (a) the persons have on-site operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications; or
- (b) the person or persons have day-to-day operational control of those activities at a construction site that are necessary to ensure compliance with a storm water pollution prevention plan (SWP3) for the site or other permit conditions (e.g., they are authorized to direct workers at a site to carry out activities required by the SWP3 or comply with other permit conditions).

Secondary Operator – The persons or entity whose operational control is limited to:

- (a) the employment of other operators, such as a general contractor to perform or supervise construction activities; or
- (b) ability to approve or disapprove changes to plans and specifications, but who does not have day-to-day on-site operational control over construction activities at the site.

Secondary operators must either prepare their own SWP3 or participate in a shared SWP3 that covers the areas of construction site, where they have control over the construction plans and specifications.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.1 SITE SPECIFIC STORM WATER POLLUTION PREVENTION PLAN (SWP3)

- A. Prepare a SWP3 following Part III of the Construction General Permit and the “Storm Water Management Handbook for Construction Activities” issued by Harris County. If conflicts exist between the Construction General Permit and the handbook, the more stringent requirements will apply.
- B. Update or revise the SWP3 as needed during the construction following Part III,

Section E of the Construction General Permit.

- C. Submit the SWP3 and any updates or revisions to Engineer for review and address comments prior to commencing, or continuing, construction activities.

3.2 NOTICE OF INTENT FOR LARGE CONSTRUCTION ACTIVITY

- A. Fill out, sign, and date TCEQ Form 20022 (03/06/2018) Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity under the TPDES Construction General Permit (TXR150000), **ATTACHMENT 1** of this Section 01410.
- B. Transmit the signed Contractor's copy of TCEQ Form 20022 (03/06/2018), along with a \$325.00 application fee for a paper NOI and \$225 application fee for an electronic NOI. If using the paper NOI the check should be made out to Texas Commission on Environmental Quality along with the completed Payment Submittal Form to Engineer. This is submitted separately to the TCEQ's Cashier's Office as instructed on the application.
- C. Engineer will complete a separate TCEQ Form 20022 (03/06/2018) for Authority's Notice of Intent, and will submit both NOIs, along with application fees, to the TCEQ.
- D. Submission of the Notice of Intent form by both the Authority and Contractor to TCEQ is required a minimum of seven days before Commencement of Construction Activities.

3.3 CONSTRUCTION SITE NOTICE FOR LARGE CONSTRUCTION ACTIVITY

- A. Fill out, sign, and date the Large Construction Site Notice, Attachment 2 to TPDES General Permit No. TXR150000, "Large Construction Site Notice", for Primary Operator and/or Secondary Operator as deemed necessary, **ATTACHMENT 2** of this Section 01410.
- B. Transmit the signed Large Construction Site Notice(s) to Engineer at least seven days prior to Commencement of Construction Activity.

3.4 CONSTRUCTION SITE NOTICE FOR SMALL CONSTRUCTION ACTIVITY

- A. Fill out, sign, and date the Small Construction Site Notice, Attachment 3 to TPDES General Permit No. TXR150000, "Small Construction Site Notice", **ATTACHMENT 3** of this Section 01410.
- B. Transmit the signed Small Construction Site Notice to Engineer at least seven days prior to Commencement of Construction Activity.

3.5 CERTIFICATION REQUIREMENTS

- A. Fill out TPDES Operator's Information form, **ATTACHMENT 4** of this Section 01410, including Contractor's name, address, and telephone number, and the names of persons or firms responsible for maintenance and inspection of erosion and sediment control measures. Use multiple copies as required to document full information.
- B. Contractor and Subcontractors shall sign and date the Contractor's / Subcontractor's Certification for TPDES Permitting, **ATTACHMENT 5** of this Section 01410. Include this certification with other Project certification forms.
- C. Submit properly completed certification forms to Engineer for review before beginning construction operations.
- D. Conduct inspections in accordance with TCEQ requirements. Ensure persons or firms responsible for maintenance and inspection of erosion and sediment control measures read, fill out, sign, and date the Erosion Control Contractor's Certification for Inspection and Maintenance. Use the Authority Storm Water Pollution Prevention Plan, Construction Site Inspection Report, **ATTACHMENT 6** of this Section 01410 to record maintenance inspections and repairs.

3.6 RETENTION OF RECORDS

- A. Keep a copy of this document and the SWP3 in a readily accessible location at the construction site from Commencement of Construction Activity until submission of the Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under TPDES Construction General Permit (TXR150000). Contractors with day-to-day operational control over SWP3 implementation shall have a copy of the SWP3 available at a central location, on-site, for the use of all operators and those identified as having responsibilities under the SWP3. Upon submission of the NOT, submit all required forms and a copy of the SWP3 with all revisions to Engineer.

3.7 REQUIRED NOTICES

- A. Post the following notices from effective date of the SWP3 until date of final site stabilization as defined in the Construction General Permit:
 - 1. Post the TPDES permit number for Large Construction Activity, with a signed TCEQ Construction Site Notice for Large or Small Construction Activity. Signed copies of the Authority's and Contractor's NOI may also be posted, but is not required per the Construction General Permit.
 - 2. Post Construction Site Notice(s) near the main entrance of the construction site in a prominent place where it is safely and readily available for viewing

by the General Public, Local, State, and Federal Authorities. Post name and telephone number of Contractor's local contact person, brief project description and location of the SWP3.

- a. If posting near a main entrance is not feasible due to safety concerns, coordinate posting with Engineer to conform to requirements of the Construction General Permit.
 - b. If Project is a linear construction project (e.g.: road, utilities, etc.), post notice in a publicly accessible location near active construction. Move notice as necessary.
3. Post a notice to equipment and vehicles operators, instructing them to stop, check, and clean tires of debris and mud before driving onto traffic lanes. Post at each stabilized construction access area.
 4. Post a notice of waste disposal procedures in a readily visible location on site.

3.8 ON-SITE WASTE MATERIAL STORAGE

- A. On-site waste material storage shall be self-contained and shall satisfy appropriate local, state, and federal rules and regulations.
- B. Prepare list of waste material to be stored on-site. Update list as necessary to include up-to-date information. Keep a copy of updated list with the SWP3.
- C. Prepare description of controls to reduce pollutants generated from on-site storage. Include storage practices necessary to minimize exposure of materials to storm water, and spill prevention and response measures consistent with best management practices. Keep a copy of the description with the SWP3.

3.9 NOTICE OF TERMINATION

- A. Submit a NOT, **ATTACHMENT 7** of this Section 01410, to Engineer within 30 days after:
 1. Final stabilization has been achieved on all portions of the site that are the responsibility of the Contractor; or
 2. Another operator has assumed control over all areas of the site that have not been stabilized; and
 3. All silt fences and other temporary erosion controls have either been removed, scheduled to be removed as defined in the SWP3, or transferred to a new operator if the new operator has sought permit coverage.

- B. Engineer will complete Authority's NOT and submit Contractor and Authority's notices to the TCEQ and MS4 entities.

END OF SECTION

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Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity under the TPDES Construction General Permit (TXR150000)

For help completing this application, read the TXR150000 NOI Instructions
(TCEQ-20022-Instructions).

TCEQ Office Use Only

TPDES Permit Number: TXR15 | | | | | - NO

GIN Number: | | | | |

A. Construction Site Operator ☐ New ☐ No Change Customer Reference Number: CN _____

Name: _____

Mailing Address: _____ City: _____ State: _____ Zip Code: _____

Country Mailing Information (if outside USA) Territory: _____ Country Code: _____ Postal Code: _____

Phone Number: _____ Extension: _____ Fax Number: _____

E-mail Address: _____

Type of Operator: ☐ Individual ☐ Sole Proprietorship - D.B.A. ☐ Partnership ☐ Corporation ☐ Federal Government
☐ State Government ☐ County Government ☐ City Government ☐ Other: _____

Independent Operator? ☐ Yes ☐ No Number of Employees: ☐ 0-20 ☐ 21-100 ☐ 101-250 ☐ 251-500 ☐ 501 or higher

Federal Tax ID: _____ State Franchise Tax ID Number: _____ DUNS Number: _____

B. Billing Address

Name: _____

Mailing Address: _____ City: _____ State: _____ Zip Code: _____

Country Mailing Information (if outside USA) Territory: _____ Country Code: _____ Postal Code: _____

C. Project / Site Information ☐ New ☐ No Change Regulated Entity Reference Number: RN _____

Name: _____

Mailing Address: _____ City: _____ State: _____ Zip Code: _____

Physical Address: _____ City: _____ County: -- _____ Zip Code: _____

Location Access Description: _____

Latitude: ____° ____' ____" N Longitude: ____° ____' ____" W Degrees (°), Minutes ('), and Seconds (")
 Latitude: _____ Longitude: - _____ Decimal Form

Standard Industrial Classification (SIC) code: _____ Also, describe the construction activity at this site (do not repeat the SIC code): _____

Has a storm water pollution prevention plan been prepared as specified in the general permit (TXR150000)? ☐ Yes ☐ No

Estimated area of land disturbed (to the nearest acre): _____ Is the project / site located on Indian Country Lands? ☐ Yes ☐ No

Does this project / site discharge storm water into a municipal separate storm sewer system (MS4)? ☐ Yes ☐ No

If yes, provide the name of the MS4 operator: _____

Provide the name or segment number of the water body that receives storm water from this project / site: _____

D. Contact - If the TCEQ needs additional information regarding this application, who should be contacted?

Name: _____ Title: _____

Phone Number: _____ Extension: _____ Fax Number: _____

E-mail Address: _____

E. Payment Information - Check / Money Order Number: _____ Name on Check / Money Order: _____

F. Certification

I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Construction Site Operator:

Prefix: _____ First: _____ Middle: _____

Last: _____ Suffix: _____ Title: _____

Signature: _____ Date: _____

If you have questions on how to fill out this form or about the storm water program, please contact us at (512) 239-4671.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at (512) 239-3282.

The completed NOI must be mailed to the following address. Use the attached document to submit the \$100 application fee. Please note that the NOI and application fee are submitted separately to different addresses.

**Texas Commission on Environmental Quality
Storm Water & General Permits Team; MC - 228
P.O. Box 13087
Austin, Texas 78711-3087**

TCEQ-20022 (05/03)

Page 1 of 2

ATTACHMENT 1

Texas Commission on Environmental Quality
Payment Submittal Form

The storm water application fee shall be sent under separate cover to the Texas Commission on Environmental Quality.

This form must be used to submit your Storm Water Application Fee. Please complete the following information, staple your check in the space provided at the bottom of this document, and mail it to:

BY REGULAR U.S. MAIL

Texas Commission on Environmental Quality
Financial Administration Division
Cashier's Office, MC-214
P.O. Box 13088
Austin, TX 78711-3088

BY OVERNIGHT/EXPRESS MAIL

Texas Commission on Environmental Quality
Financial Administration Division
Cashier's Office, MC-214
12100 Park 35 Circle
Austin, TX 78753

Fee Code: GPA

Storm Water General Permit: TXR150000

Check / Money Order No: _____ Amount of Check/Money Order: _____

Date of Check or Money Order: _____

Name on Check or Money Order: _____

Facility / Site Name: _____

Facility / Site Physical Address: _____

City: _____ Zip Code: _____

Staple Check In This Space

ATTACHMENT 1

Completing the Notice of Intent for Storm Water Discharges Associated with Construction Activity under the TPDES Construction General Permit (TXR150000)

A. Construction Site Operator Information

Check boxes and Customer Reference Number

These boxes designate the operator's status as a TCEQ "customer"—in other words, an individual or business that is involved in an activity that we regulate. We assign each customer a number that begins with "CN," followed by nine digits. **This is not a permit number, registration number, or license number.** In the remainder of this section, we will use "this customer" to mean the operator for Part A of the form.

- If this customer has not been assigned a Customer Reference Number or if this number is unknown, check "New" and leave the space for the Customer Reference Number blank.
- If this customer has already been assigned this number, enter the operator's Customer Reference Number and:
 - Check "No Change" if all the remaining customer information is the same as previously reported. However, you must still complete most blanks in this form for this notice of intent to be valid.
 - If this customer's information has changed since the last time it was reported to the TCEQ, check neither box and complete the remainder of this notice of intent.
- **Do not enter a permit number, registration number, or license number in place of the Customer Reference Number.**

Name

Enter the legal name of this customer as authorized to do business in Texas. Include any abbreviations (LLC, Inc., etc.).

Mailing Address

Enter a central and general mailing address for this customer to receive mail from the TCEQ. For example, if this customer is a large company, this address might be the corporate or regional headquarters. On the other hand, for a smaller business, this address could be the same as the site address.

If this is a street address, please follow US Postal Service standards. In brief, these standards require this information in this order:

- the "house" number—for example, the 1401 in 1401 Main St
- if there is a direction before the street name, the one- or two-letter abbreviation of that direction (N, S, E, W, NE, SE, SW, or NW)
- the street name (if a numbered street, do not spell out the number—for example, 6th St, not Sixth St)
- an appropriate abbreviation of the type of street—for example, St, Ave, Blvd, Fwy, Exwy, Hwy, Cr, Ct, Ln
- if there is a direction after the street name, the one- or two-letter abbreviation of that direction (N, S, E, W, NE, SE, SW, or NW)
- if there is a room number, suite number, or company mail code

City, State, and ZIP Code

Enter the name of the city, the two-letter USPS abbreviation for the state (for example, TX), and the ZIP Code. (Enter the full ZIP+4 if you know it.)

Country Mailing Information

If this address is **outside** the United States, enter the territory name, country code, and any non-ZIP mailing codes or other non-U.S. Postal Service features here. If this address is **inside** the United States, leave these spaces blank.

Phone Number and Extension

This number should correspond to this customer's mailing address given earlier. Enter the area code and phone number here. Leave "Extension" blank if this customer's phone system lacks this feature.

Fax Number

This number should correspond to this customer's mailing address given earlier. Enter the area code and fax number here.

E-mail Address

As with the mailing address, this should be a general address that is appropriate for e-mail to this customer's central or regional headquarters, if applicable.

If "No Change" was checked for this customer, you may skip the rest of the fields in this part of the form and continue to the next part of the NOI.

Type of Operator

Check **only one** box.

Check ...	if this customer ...
Individual	is a person and has not established a business to do whatever causes them to be regulated by us.
Sole Proprietorship—D.B.A.	is a business that is owned by only one person and has not been incorporated. This business may: • be under the person's name • have its own name ("doing business as" or d.b.a.) • have any number of employees
Partnership	is a business that is established as a partnership as defined by the Texas Secretary of State's Office.
Corporation	meets all of these conditions: • is a legally incorporated entity under the laws of any state or country • is recognized as a corporation by the Texas Secretary of State • has proper operating authority to operate in Texas
Federal, state, county, or city government (as appropriate)	is either an agency of one of these levels of government or the governmental body itself (if a utility district, water district, tribal government, college district, council of governments, or river authority, check "Other" and write in the specific type of government).
Other	fits none of the above descriptions. Enter a short description of the type of customer in the blank provided.

Independent Operator?

Check "No" if this customer is a subsidiary or part of a larger company. Otherwise, check "Yes."

Number of Employees

Check one box to show the number of employees for this customer's entire company, at all locations. **This is not necessarily the number of employees at the site named in this NOI.**

Federal Tax ID

All businesses, except for some small sole proprietors, should have a federal taxpayer identification number (TIN). Enter this number here. Use no prefixes, dashes, or hyphens. Individuals and sole proprietors do not need to provide a federal tax ID.

State Franchise Tax ID

Corporations and limited liability companies that operate in Texas are issued a franchise tax identification number. If this customer is a corporation or limited liability company, enter this number here.

DUNS Number

Most businesses have a DUNS (Data Universal Numbering System) number issued by Dun and Bradstreet Corp. If this customer has one, enter it here.

B. Billing Address

We will mail the annual fee invoice for this site to the address entered in this section.

Name

Enter the legal name of the person or business to which we should mail this site's fee invoice each year.

Mailing Address

Enter the specific mailing address to which we should mail this site's fee invoice each year. If this is a street address, please follow the US Postal Service standards as described under "A. Construction Site Operator Information" on page 1 of these instructions.

City, State, and ZIP Code

Enter the name of the city, the two-letter USPS abbreviation for the state (for example, TX), and the ZIP Code. (Enter the full ZIP+4 if you know it.)

Country Mailing Information

If this address is **outside** the United States, enter the territory name, country code, and any non-ZIP mailing codes or other non-U.S. Postal

ATTACHMENT 1

Service features here. If this address is *inside* the United States, leave these spaces blank.

C. Project / Site Information

Check boxes and Regulated Entity Reference Number

These boxes designate this site's status as a TCEQ "regulated entity"—in other words, a location where an activity that we regulate occurs. We assign each regulated entity a number that begins with "RN," followed by nine digits. **This is not a permit number, registration number, or license number.**

- If this site has not been assigned a Regulated Entity Reference Number or if this number is unknown, check "New" and leave the space for the Regulated Entity Reference Number blank.
- If this site has already been assigned this number, enter the Regulated Entity Reference Number and:
 - Check "No Change" if all the remaining information is the same as previously reported. However, even if there has been no change, you must complete this section at least through "E-mail Address" for this NOI to be valid.
 - If this site's information has changed since the last time it was reported to the TCEQ, check neither box and complete the remainder of this notice of intent.
- **Do not enter a permit number, registration number, or license number in place of the Regulated Entity Reference Number.**

Name

Enter the name by which you want this site to be known to the TCEQ.

Mailing Address

Enter the specific mailing address for this site. If this is a street address, please follow the US Postal Service standards as described under "A. Construction Site Operator Information" on page 1 of these instructions. If the project / site's mailing address is the same as what is provided in Section A, you may enter "Same as Section A."

City, State, and ZIP Code

Enter the name of the city, the two-letter USPS abbreviation for the state (for example, TX), and the ZIP Code. (Enter the full ZIP+4 if you know it.)

Physical Address

Enter the physical address of the site itself. TCEQ staff should be able to use this address to find the site. Please follow the US Postal Service standards as described under "A. Construction Site Operator Information" on page 1 of these instructions. If the project / site does not have a physical address, enter "No Address."

City, County, and ZIP Code

Enter the name of the city, the county, and the ZIP Code. (Enter the full ZIP+4 if you know it.) This information must be provided even if you have entered "No Address" in the previous field.

Location Access Description

Enter a physical description of the location of the site based on highway intersections and/or permanent landmarks.

Latitude and Longitude

Enter the latitude and longitude of the site in *either* degrees, minutes, and seconds *or* decimal form.

For help obtaining the latitude and longitude, go to:

<http://www.tnrc.state.tx.us/gis/drgview.html>

Standard Industrial Classification (SIC) Code and Activity Description

Provide the SIC code that best describes the construction activity being conducted at the site.

For help with SIC codes, go to:

<http://www.osha.gov/oshstats/sicser.html>

In addition to the SIC code, you must also provide a description of the construction activity being conducted at the site. This may include such descriptions as: "Apartment Building Construction" or "Shopping Center Construction."

Storm Water Pollution Prevention Plan

This plan identifies the areas and activities that could produce contaminated runoff at your site and then tells how you will ensure that this contamination is mitigated. For example, in describing your mitigation measures, your site's plan might identify the devices that collect and filter storm water, tell how those devices are to be maintained, and tell how frequently that maintenance is to be carried out. **You must develop this plan before you complete this NOI.** This plan must be available for a TCEQ investigator to review on request. Specific requirements for the development of the plan

can be found in the *Texas Pollutant Discharge Elimination System Construction General Permit (TXR150000)*.

Estimated Area of Land Disturbed

Provide the approximate number of acres that the construction site will disturb. It is appropriate to enter a value less than 5, only if the project is part of a larger common plan that disturbs five or more acres. If the acreage is less than 1, enter 1. "Disturb" means any clearing, grading, excavating, or other similar activities.

Is the site located on Indian Country Lands?

Check "Yes" only if the site is on a reservation or other areas designated by the federal government as Indian Country Lands. If not, check "No."

Destination of Storm Water Discharge

The storm water from your site eventually reaches a receiving water body such as a local stream or lake, possibly via a drainage ditch. The discharge may initially be into a municipal separate storm sewer system (MS4). Check the appropriate boxes for whether storm water is discharged into an MS4. If you checked "Yes" to "An MS4?", then enter the name of the entity that operates the storm sewer—often a city, town, or utility district, but possibly another form of government.

You must also provide the name of the water body that receives the discharge from the construction site (a local stream or lake). Storm water may be discharged directly to a receiving stream or via a storm sewer system. If known, please include the segment number if the discharge is to a classified water body.

For a map that includes segment numbers, go to:

<http://www.tnrc.state.tx.us/water/quality/data/index.html>

D. Contact

Give all the relevant information for the person whom TCEQ can contact if there are questions about any of the information on this form—perhaps the same person who completed the form.

E. Payment Information

Provide the number and account holder name from the check or money order used to pay the \$100 application fee.

F. Certification

The operator must sign and date this statement to validate this NOI. Be sure to enter the full legal name of the person signing the form and the relevant title—for example, "Operator," "Vice-President," or "Partner." Use the "Prefix" blank for such titles as Dr., Mr., or Ms., as desired. Use the "Suffix" blank for such designations as Ph.D., Jr., Sr., III, or J.D., if applicable.

For a corporation, the application shall be signed by a responsible corporate officer. A responsible corporate officer means a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding \$25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. Corporate procedures governing authority to sign permit applications may provide for assignment or delegation to applicable corporate positions rather than to specific individuals.

For a partnership or sole proprietorship, the application shall be signed by a general partner or the proprietor, respectively.

For a municipality, state, federal, or other public agency, the application shall be signed by either a principal executive officer or a ranking elected official. For purposes of this application, a principal executive officer of a federal agency includes the chief executive officer of the agency, or a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., regional administrator of the United States Environmental Protection Agency).

Questions?

If you have questions about any of the information on this form, contact our Storm Water Program at 512/239-4671 or look for "Storm Water" on our Web site:

www.tceq.state.tx.us

ATTACHMENT 2



CONSTRUCTION SITE NOTICE
FOR THE
Texas Commission on Environmental Quality (TCEQ)
Storm Water Program
TPDES GENERAL PERMIT TXR150000

The following information is posted in compliance with **Part II.D.2.** of the TCEQ General Permit Number TXR150000 for discharges of storm water runoff from construction sites. Additional information regarding the TCEQ storm water permit program may be found on the internet at:

www.tnrcc.state.tx.us/permitting/waterperm/wwperm/tpdestorm

Contact Name and Phone Number:	
Project Description: (Physical address or description of the site's location, estimated start date and projected end date, or date that disturbed soils will be stabilized)	
Location of Storm Water Pollution Prevention Plan :	

For Construction Sites Authorized Under Part II.D.2. (Obtaining Authorization to Discharge) the following certification must be completed:

I _____ (Typed or Printed Name Person Completing This Certification) certify under penalty of law that I have read and understand the eligibility requirements for claiming an authorization under Part II.D.2. of TPDES General Permit TXR150000 and agree to comply with the terms of this permit. A storm water pollution prevention plan has been developed and implemented according to permit requirements. A copy of this signed notice is supplied to the operator of the MS4 if discharges enter an MS4 system. I am aware there are significant penalties for providing false information or for conducting unauthorized discharges, including the possibility of fine and imprisonment for knowing violations.

Signature and Title

Date

ATTACHMENT 3
TPDES OPERATOR'S INFORMATION

Owner's Name and Address: West Harris County Regional Water Authority

Mr. _____
(Authority Official)

(Department)

Contractors' Names and Addresses:

General Contractor:

Telephone:

Site Superintendent:

Telephone:

Erosion Control and
Maintenance Inspection:

Telephone:

Subcontractors' Names and Addresses:

Phone: _____

Phone: _____

Note: Insert name, address, and telephone number of person or firms

ATTACHMENT 4

CONTRACTOR'S / SUBCONTRACTOR'S

CERTIFICATION FOR TPDES PERMITTING

I certify under penalty of law that I understand the terms and conditions of TPDES General Permit No. TXR150000 and the Storm Water Pollution Prevention Plan for the construction site identified as part of this certification.

Signature: _____
Name: (printed or typed) _____
Title: _____
Company: _____
Address: _____
Date: _____

Signature: _____
Name: (printed or typed) _____
Title: _____
Company: _____
Address: _____
Date: _____

Signature: _____
Name: (printed or typed) _____
Title: _____
Company: _____
Address: _____
Date: _____



ATTACHMENT 5 EPA NPDES Construction Inspection Form



The following inspection is being performed in compliance with Part IV.D.4. of the NPDES Region 6 Storm Water Construction General Permit [63 Fed. Reg. 36502] and being retained in accordance with Part V of the Permit. Qualified personnel (provided by the permittee or cooperatively by multiple permittees) shall inspect disturbed areas of the construction site that have not been finally stabilized, areas used for storage of materials that are exposed to precipitation, placement and effectiveness of structural control measures, and locations where vehicles enter or exit the site. Inspections shall be performed at least once every 14 days and within 24 hours of the end of a storm event of 0.5 inches or greater. Where sites have been temporarily stabilized, runoff is unlikely due to winter conditions, or during seasonal arid periods in arid areas (0-10 inches of rainfall annually) and semi-arid areas (10-20 inches annually) such inspections shall be conducted at least once every month. This form is primarily intended for use with construction projects in Texas and New Mexico. Permittees on Indian Country lands in Oklahoma, Louisiana and Arkansas and some oil and gas facilities in Oklahoma may use this form if they are eligible for this permit. Other facilities need to check with their NPDES authority before using this form.

If you do not know your NPDES Permit Number, contact the NOI Processing Center at (301)495-4145. This form was prepared as an example and it is not a required form for use with the permit. Alternative forms may be used if they contain all of the required information as set forth in the permit. This form and additional information regarding the NPDES Region 6 storm water program may be found on the Internet at <http://www.epa.gov/region6/sw/>. Any person with a complaint about the operation of this facility in regards to this permit should contact EPA Region 6 at (214)665-7112.

Permit Number(s) covered by this inspection (e.g. owners, developers, general contractor, builders)		
Signature and Certification in accordance with Part VI.G of the permit:	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. Signature _____ Date _____	
Date of Inspection		
Inspector Name		
Is there a copy of the permit language with the SWPPP?	☐ YES	☐ NO
Is the inspector qualified and are the qualifications documented in the SWPPP?	☐ YES	☐ NO
Is an NPDES storm water construction sign posted at the entrance for all permittees?	☐ YES	☐ NO
You may want to use EPA Region 6 construction checklist to assure components of the SWPPP are complete. This form, the construction sign, and the checklist are available on the Region 6 NPDES Storm Water Forms and Documents web page which may be found on the internet at http://www.epa.gov/earth1r6/gen/w/formsww.htm. In addition to the checklist, you should provide a narrative (see next page) on the existing Best Management Practices and Structural Controls found during each inspection. Any problems identified in an inspection should be corrected within 7 days. The inspection should cover all components of the SWPPP and all potential pollutants. While eroded soil is the primary pollutant of concern, do not forget to inspect for other pollutant sources such as fuel tanks, paints, solvents, stabilization materials, concrete hardener, batch plants, and construction debris. The inspector will need to update the SWPPP to reflect findings of the inspection. The site map should be updated after an inspection to show controls that have been added or removed, to ensure the site map is kept current in accordance with Part IV.C. of the permit.		

Revision 4, March 1, 2000

ATTACHMENT 5

Narrative Findings of the inspection:

Observations should include any findings of Best Management Practices or controls that are not in accordance with the SWPPP. If a control is not in place or failed, observe the reason why. A control removed temporarily for work is not necessarily a violation if properly recorded in the SWPPP. If it has been removed, record why it was removed and, if applicable, when it will be reinstalled. If the control has failed, observe the conditions so a conclusion may be made as to whether the control failed for improper maintenance or improper design. The qualified inspector will know when a failed control is inadequate and should be replaced by an improved control mechanism. Qualified inspectors are to have authority to make changes to the SWPPP to assure compliance. Controls that have not been installed should be given a reason why they are not installed and/or a scheduled date for installation if they are designed for a later phase of construction. After the inspection, the SWPPP and its site map should be updated to reflect current conditions of controls and Best Management Practices at the time of the inspection. This includes removing uninstalled controls from the site map or otherwise denoting on the site map if they are no longer installed if the controls have been removed because they are no longer necessary (e.g. stabilization has been achieved in that area).

Revision 4, March 1, 2000

ATTACHMENT 6



**Notice of Termination (NOT) for Storm
Water Discharges Associated with
Construction Activity under the TPDES
Construction General Permit (TXR150000)**

TCEQ Office Use Only

TPDES Permit Number: TXR15:____ - NO
GIN Number: _____

For help completing this application, read the TXR150000 NOI Instructions (TCEQ-20023-Instructions).

A. TPDES Permit Number: TXR15:_____

B. Construction Site Operator

Customer Reference Number: CN:_____

Name: _____

Mailing Address: _____

City: _____ State: -- _____ Zip Code: _____

Country Mailing Information (if outside USA) Territory: _____ Country Code: _____ Postal Code: _____

Phone Number: _____ Extension: _____ Fax Number: _____

E-mail Address: _____

C. Project / Site Information

Regulated Entity Reference Number: RN:_____

Name: _____

Physical Address: _____

Location Access Description: _____

City: _____ County: -- _____ Zip Code: _____

D. Contact - If the TCEQ needs additional information regarding this termination, who should be contacted?

Name: _____ Title: _____

Phone Number: _____ Extension: _____ Fax Number: _____

E-mail Address: _____

E. Certification

I certify under penalty of law that authorization under the TPDES Construction General Permit (TXR150000) is no longer necessary based on the provisions of the general permit. I understand that by submitting this Notice of Termination, I am no longer authorized to discharge storm water associated with construction activity under the general permit TXR150000, and that discharging pollutants in storm water associated with construction activity to waters of the U.S. is unlawful under the Clean Water Act where the discharge is not authorized by a TPDES permit. I also understand that the submittal of this Notice of Termination does not release an operator from liability for any violations of this permit or the Clean Water Act.

Construction Site Operator Representative:

Prefix: _____ First: _____ Middle: _____

Last: _____ Suffix: _____

Title: _____

Signature: _____ Date: _____

If you have questions on how to fill out this form or about the storm water program, please contact us at (512) 239-4671. Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at (512) 239-3282.

The completed NOT must be mailed to the following address:

**Texas Commission on Environmental Quality
Storm Water & General Permits Team; MC - 228
P.O. Box 13087
Austin, Texas 78711-3087**

ATTACHMENT 7
Completing the Notice of Termination for Storm Water Discharges
Associated with Construction Activity
under the TPDES Construction General Permit (TXR150000)

Who May File a Notice of Termination (NOT) Form

Permittees disturbing 5 acres or more (or part of a larger common plan of development or sale disturbing 5 acres or more) who are presently covered under the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit must submit a Notice of Termination (NOT) when final stabilization has been achieved on all portions of the site that is the responsibility of the permittee; or another permitted operator has assumed control over all areas of the site that have not been finally stabilized and all silt fences and other temporary erosion controls have either been removed, scheduled for removal as defined in the SWP3, or transferred to a new operator if the new operator has sought permit coverage. Erosion controls that are designed to remain in place for an indefinite period, such as mulches and fiber mats, are not required to be removed or scheduled for removal.

Final Stabilization occurs when either of the following conditions are met:

- (a) All soil disturbing activities at the site have been completed and a uniform (e.g., evenly distributed, without large bare areas) perennial vegetative cover with a density of 70% of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.
- (b) For individual lots in a residential construction site by either:
 - (1) the homebuilder completing final stabilization as specified in condition (a) above; or
 - (2) the homebuilder establishing temporary stabilization for an individual lot prior to the time of transfer of the ownership of the home to the buyer and after informing the homeowner of the need for, and benefits of, final stabilization.
- (c) For construction activities on land used for agricultural purposes (e.g., pipelines across crop or range land), final stabilization may be accomplished by returning the disturbed land to its preconstruction agricultural use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to a surface water and areas which are not being returned to their preconstruction agricultural use must meet the final stabilization conditions of condition (a) above.

A. TPDES Permit Number

Provide the TPDES permit number assigned to the operator of the construction site.

B. Construction Site Operator Information

Customer Reference Number

This number designates the operator's status as a TCEQ "customer"—in other words, an individual or business that is involved in an activity that we regulate. We assign each customer a number that begins with "CN," followed by nine digits. ***This is not a permit number, registration number, or license number.*** In the remainder of this section, we will use "this customer" to mean the operator for Part B of the form.

- If this customer has not been assigned a Customer Reference Number, leave the space for the Customer Reference Number blank.
- If this customer has already been assigned this number, enter the operator's Customer Reference Number.
- ***Do not enter a permit number, registration number, or license number in place of the Customer Reference Number.***

Name

Enter the legal name of this customer as authorized to do business in Texas. Include any abbreviations (LLC, Inc., etc.).

Mailing Address

Enter a central and general mailing address for this customer to receive mail from the TCEQ. For example, if this customer is a large company, this address might be the corporate or regional headquarters. On the other hand, for a smaller business, this address could be the same as the site address.

If this is a street address, please follow US Postal Service standards. In brief, these standards require this information in this order:

- the "house" number—for example, the 1401 in 1401 Main St
- if there is a direction before the street name, the one- or two-letter abbreviation of that direction (N, S, E, W, NE, SE, SW, or NW)
- the street name (if a numbered street, do not spell out the number—for example, 6th St, not Sixth St)
- an appropriate abbreviation of the type of street—for example, St, Ave, Blvd, Fwy, Exwy, Hwy, Cr, Ct, Ln
- if there is a direction after the street name, the one- or two-letter abbreviation of that direction (N, S, E, W, NE, SE, SW, or NW)
- if there is a room number, suite number, or company mail code

City, State, and ZIP Code

Enter the name of the city, the two-letter USPS abbreviation for the state (for example, TX), and the ZIP Code. (Enter the full ZIP+4 if you know it.)

ATTACHMENT 7

Country Mailing Information

If this address is **outside** the United States, enter the territory name, country code, and any non-ZIP mailing codes or other non-U.S. Postal Service features here. If this address is **inside** the United States, leave these spaces blank.

Phone Number and Extension

This number should correspond to this customer's mailing address given earlier. Enter the area code and phone number here. Leave "Extension" blank if this customer's phone system lacks this feature.

Fax Number

This number should correspond to this customer's mailing address given earlier. Enter the area code and fax number here.

E-mail Address

As with the mailing address, this should be a general address that is appropriate for e-mail to this customer's central or regional headquarters, if applicable.

C. Project / Site Information

Regulated Entity Reference Number

This number designates this site's status as a TCEQ "regulated entity"—in other words, a location where an activity that we regulate occurs. We assign each regulated entity a number that begins with "RN," followed by nine digits. ***This is not a permit number, registration number, or license number.***

- If this site has not been assigned a Regulated Entity Reference Number, leave the space for the Regulated Entity Reference Number blank.
- If this site has already been assigned this number, enter the Regulated Entity Reference Number.
- ***Do not enter a permit number, registration number, or license number in place of the Regulated Entity Reference Number.***

Name

Enter the name by which you want this site to be known to the TCEQ.

Physical Address

Enter the physical address of the site itself. TCEQ staff should be able to use this address to find the site.

Location Description

Enter a physical description of the location of the site based on highway intersections and/or permanent landmarks.

City, County, and ZIP Code

Enter the name of the city, the county, and the ZIP Code. (Enter the full ZIP+4 if you know it.)

D. Contact

Give all the relevant information for the person whom TCEQ can contact if there are questions about any of the information on this form—perhaps the same person who completed the form.

E. Certification

The operator must sign and date this statement to validate this NOI. Be sure to enter the full legal name of the person signing the form and the relevant title—for example, "Operator," "Operator's attorney," or "Senior Site Manager." Use the "Prefix" blank for such titles as Dr., Mr., or Ms., as desired. Use the "Suffix" blank for such designations as Ph.D., Jr., Sr., III, or J.D., if applicable.

For a corporation, the application shall be signed by a responsible corporate officer. A responsible corporate officer means a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding \$25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. Corporate procedures governing authority to sign permit applications may provide for assignment or delegation to applicable corporate positions rather than to specific individuals.

For a partnership or sole proprietorship, the application shall be signed by a general partner or the proprietor, respectively.

For a municipality, state, federal, or other public agency, the application shall be signed by either a principal executive officer or a ranking elected official. For purposes of this application, a principal executive officer of a federal agency includes the chief executive officer of the agency, or a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g. regional administrator of the United States Environmental Protection Agency).

Questions?

If you have questions about any of the information on this form, contact our Storm Water Program at 512/239-4671 or look for "Storm Water" on our Web site:

www.tceq.state.tx.us

Section 01422

REFERENCE STANDARDS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Section includes general quality assurance as related to Reference Standards and a list of references.

1.2 QUALITY ASSURANCE

- A. For Products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on the date as stated in the General Conditions.
- C. Request clarification from Engineer before proceeding should specified reference standards conflict with Contract documents.

1.3 SCHEDULE OF REFERENCES

AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W, Suite 249 Washington, DC 20001
ACI	American Concrete Institute 38800 Country Club Drive Farmington Hills, MI 48331-3439
AGC	Associated General Contractors of America 2300 Wilson Blvd, Suite 300 Arlington, VA 22201
AI	Asphalt Institute 2696 Research Park Drive Lexington, KY 40511-8480

AITC	American Institute of Timber Construction 7012 S. Revere Parkway, Suite 140 Centennial, CO 80112
AISC	American Institute of Steel Construction 130 East Randolph Street, Suite 2000 Chicago, Illinois 60601
AISI	American Iron and Steel Institute 25 Massachusetts Ave NW, Suite 800 Washington, DC 20001
ASME	American Society of Mechanical Engineers Two Park Avenue New York, NY 10016-5990
ANSI	American National Standards Institute 1899 L Street, NW, 11 th Floor Washington, D.C. 20036
APA	American Plywood Association 7011 S. 19th Street Tacoma, WA 98466-5333
API	American Petroleum Institute 1220 L Street, NW Washington, DC 20005-4070
AREMA	American Railway Engineering and Maintenance of Way Association 4501 Forbes Blvd, Suite 130 Lanham, Maryland 20706
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive, PO Box C700 West Conshohocken, PA 19428-2959
AWPA	American Wood Preservers' Association (or American Wood Protection Association) 100 Chase Park S, Suite 116 Birmingham, AL 35244-1851
AWS	American Welding Society 8669 NW 36 Street, #130 Miami, FL 33166-6672

AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
COH	City of Houston 900 Bagby Street Houston, TX 77002
CLFMI	Chain Link Fence Manufacturers Institute 10015 Old Columbia Rd, Suite B215 Columbia, MD 21046
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173-4758
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
FS	Federal Standardization Documents General Services Administration Specifications Unit (WFSIS) 7th and D Streets, S.W. Washington, DC 20406
ICEA	Insulated Cable Engineer Association P.O. Box 493 Miamitown, OH 45041-9998
IEEE	Institute of Electrical and Electronics Engineers 2001 L St NW Washington, District of Columbia 20036
ISA	International Society of Arboriculture P.O. Box 3129 Champaign, IL 61826-3129
MIL	Military Specifications General Services Administration Specifications Unit (WFSIS) 7th and D Streets, S.W. Washington, DC 20406
NACE	National Association of Corrosion Engineers 15835 Park 10 Place Houston, TX 77084

NEMA	National Electrical Manufacturers' Association 1300 North 17 th Street, Suite 1847 Rosslyn, VA 22209
NFPA	National Fire Protection Association 1 Batterymarch Park Quincy, MA 02169
OSHA	Occupational Safety and Health Administration U.S. Department of Labor 200 Constitution Avenue, NW Room Number N3626, Washington, D.C. 20210
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077-1083
PCI	Prestressed Concrete Institute 200 West Adams, Suite 2100 Chicago, IL 60606
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021
SSPC	Society for Protective Coatings (Steel Structures Painting Council) 800 Trumbull Drive Pittsburgh, PA 15205
TAC	Texas Administrative Code Texas Water Resources Conservation Commission 1019 Brazos, Room 245 Austin, Texas 78701
TxDOT	Texas Department of Transportation 125 East 11 th Street Austin, TX 78701-2483
UL	Underwriters' Laboratories, Inc. 333 Pfingsten Road

Northbrook, IL 60062

UNI BELL UNI BELL Pipe Association (PVC Pipe Association)
2711 Lyndon B Johnson Fwy #1000
Dallas, TX 75234

PART 2 P R O D U C T S Not Used

PART 3 E X E C U T I O N Not Used

END OF SECTION

Section 01450

CONTRACTOR'S QUALITY CONTROL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Quality assurance and control of Installation and manufacturers' field services and reports.

1.2 QUALITY ASSURANCE AND CONTROL OF INSTALLATION

- A. Monitor quality control over Suppliers, manufacturers, Products, services, site conditions and workmanship, to produce work of specified quality at no additional cost to the Authority
- B. Comply fully with manufacturers' Installation instructions, including each step in sequence.
- C. Request clarification from Engineer before proceeding when manufacturers' instructions conflict with the Contract.
- D. Comply with specified standards as minimum requirements for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform the Work by persons qualified to produce a specified level of workmanship.

1.3 REFERENCES

- A. Obtain copies of standards and maintain at job site when required by individual Specification sections.

1.4 MANUFACTURERS' FIELD SERVICES AND REPORTS

- A. When specified in individual Specification sections, or as required by Engineer, provide Product suppliers' or manufacturers' technical representative to observe site conditions, conditions of surfaces and Installation, quality of workmanship, start-up of equipment, operator training, testing, adjusting and balancing of equipment as applicable and to initiate required operation. Conform to minimum time requirements for start-up operations and operator training when provided in Specification sections.
- B. At Engineer's request, submit qualifications of manufacturers' representative to Engineer 15 days in advance of required representatives' services. Representative is

subject to approval by Engineer.

- C. Manufacturer's representatives shall report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to a manufacturer's written instructions. Submit report within 14 days of observation to Engineer for review.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

SECTION 01452 (Large Diameter)

RESIDENT PROJECT REPRESENTATION

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Engineer shall furnish a Resident Project Representative (RPR), assistants, and other field staff to inspect Contractor's performance of work.
- B. Through more extensive on-site inspections of work in progress and field checks of materials and equipment by RPR and assistants, Engineer and DPOR shall endeavor to provide further protection for Owner against defects and deficiencies in work; but furnishing of such services will not make Engineer or DPOR responsible for or give Engineer or DPOR control over construction means, methods, techniques, sequences or procedures or for safety precautions or programs, or responsibility for Contractor's failure to perform work in accordance with contract documents.
- C. RPR is Engineer's representative at site. RPR will act as directed by and under supervision of Engineer, and will confer with Engineer regarding RPR's actions.

1.02 DUTIES AND RESPONSIBILITIES OF RPR

- A. Schedules: Review progress schedule, schedule of shop drawing submittals, and schedule of values prepared by Contractor and consult with Engineer concerning acceptability.
- B. Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences and other project-related meetings, and prepare and circulate copies of minutes thereof.
- C. Liaison:
 - 1. Serve as Engineer's and DPOR's liaison with Contractor, working principally through Contractor's superintendent and assist in understanding intent of contract documents; and assist Engineer and DPOR in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-site operations.
 - 2. Assist in obtaining from Engineer or DPOR additional details or information, when required for proper execution of work.
- D. Shop Drawings and Samples:
 - 1. Record date of receipt of shop drawings and samples.

2. Receive samples which are furnished at site by Contractor, and notify DPOR of availability of samples for examination.
 3. Advise DPOR and Contractor of commencement of any work requiring a shop drawing or sample when submittal has not been approved by DPOR.
- E. Review of Work, Rejection of Defective Work, Inspection and Tests:
1. RPR will conduct on-site observations of work in progress to assist DPOR in determining when work is in general proceeding in accordance with contract documents.
 2. RPR will report to DPOR whenever RPR believes that any work is unsatisfactory, faulty, damaged, defective or does not conform to contract documents. RPR will advise DPOR of work that RPR believes should be corrected, rejected, uncovered for observation, or requires special testing, inspection or approval.
 3. RPR will verify that tests, equipment and system startups and operating and maintenance training are conducted in presence of appropriate personnel, and that Contractor maintains adequate records. Observe, record and report to Engineer appropriate details relative to test procedures and startups.
 4. RPR will accompany visiting inspectors representing public or other agencies having jurisdiction over project, record results of these inspections and report to Engineer.
- F. Interpretation of Contract Documents: RPR will report to Engineer when clarifications and interpretations of contract documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.
- G. Modifications: RPR will consider and evaluate Contractor's suggestions for modifications in drawings or specifications and report with recommendations to Engineer. RPR will transmit to Contractor decisions issued by Engineer.
- H. Records:
1. RPR will maintain at job site orderly files for correspondence, reports of job conferences, shop drawings and samples, reproductions of original contract documents including all work directive changes, addenda, change orders, field orders, additional drawings issued subsequent to execution of contract, Engineer's clarifications and interpretations of contract documents, progress reports, and other project related documents.
 2. RPR will keep a daily log, record Contractor hours on job site, amount of work completed, weather conditions, data relative to questions of work directive changes, change orders or changed conditions, list of job site visitors, daily

activities, decisions, observations in general, and specific observations in more detail as in case of observing test procedures; and send copies to Engineer.

3. RPR will record names, addresses and telephone numbers of all contractors, subcontractors and major suppliers of materials and equipment.

I. Reports:

1. RPR will furnish Engineer periodic reports as required of progress of work and of Contractor's compliance with progress schedule, schedule of shop drawing and sample submittals.
2. RPR will consult with Engineer in advance of scheduled major tests, inspections or start of important phases of work.
3. RPR will draft proposed change orders and work directive changes, obtaining backup material from Contractor and recommend to Engineer change orders, work directive changes and field orders.
4. RPR will report immediately to Engineer and Owner upon occurrence of any accident.

- J. Payment Requests: RPR will review applications for payment with Contractor for compliance with established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of payment requested to schedule of values, work completed and materials and equipment delivered at site but not incorporated in work.

- K. Certificates, Maintenance and Operation Manuals: During course of work, verify that certificates, maintenance and operation manuals and other data required to be assembled and furnished by Contractor are applicable to items actually installed and in accordance with contract documents, and have this material delivered to Engineer for review and forwarding to Owner prior to final payment for work.

L. Completion:

1. Before Engineer issues a Certificate of Substantial Completion, RPR will submit to Contractor a list of observed items requiring completion or correction.
2. RPR will conduct final inspection in company of Engineer, DPOR, Owner and Contractor and prepare a final list of items to be completed or corrected.
3. RPR will observe that all items on final list have been completed or corrected and make recommendations to Engineer concerning acceptance.

1.03 LIMITATIONS OF AUTHORITY

A. Resident Project Representative:

1. Shall not authorize any deviation from contract documents or substitution of materials or equipment, unless authorized by Engineer.
2. Shall not exceed limitations of Engineer's authority as set forth in contract documents.
3. Shall not undertake any of responsibilities of Contractor, subcontractors or Contractor's superintendent.
4. Shall not advise on, issue directions relative to or assume control over any aspect of means, methods, techniques, sequences or procedures of construction unless such advice or directions are specifically required by contract documents.
5. Shall not advise on, issue directions regarding or assume control over safety precautions and programs in connection with work.
6. Shall not accept shop drawing or sample submittals from anyone other than Contractor.
7. Shall not authorize Owner to occupy project in whole or in part.
8. Shall participate in specialized field or laboratory tests or inspections conducted by others as specifically authorized by Engineer.

1.04 DEFINITIONS

- A. Working Day: Resident Project Representative assistants and other field staff to assist Engineer are not required to work on Sundays or legal holidays. When Contractor is permitted to work on Sunday or legal holiday, prior arrangements shall be made for RPR not later than 2:00 p.m. on fourth working day prior to Sunday or legal holiday.
- B. Uninspected Work: Any work performed on Sunday or legal holiday without benefit of RPR may require removal and replacement if so directed by the Inspector (an RPR). Removal and replacement shall be completed at no additional cost.

1.05 NOTICE OF NONCONFORMANCE

- A. If, during the course of this project, Contractor does not comply with Contract Documents, the following procedure may be initiated by Engineer.
 1. Notify Contractor in writing of areas of nonconformance. Immediate compliance will be required unless otherwise approved by Engineer.

2. Failure to come into compliance, will result in removal of Resident Project Representative (RPR) from site. NO PAYMENT WILL BE MADE FOR WORK PERFORMED WITHOUT RESIDENT PROJECT REPRESENTATIVE ON SITE AND NO SCHEDULE OR COST CHANGES WILL BE GRANTED.
3. Engineer will direct RPR to return to site when compliance with Contract Documents is attained and written assurances provided from principal of firm that actions which lead to nonconforming work will not occur again.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01454

TESTING LABORATORY SERVICES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Testing laboratory services and Contractor responsibilities related to those services.

1.2 REFERENCES

- A. ASTM C 1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
- B. ASTM D 3666 - Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
- C. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- D. ASTM E 329 - Standard Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- E. ISO/TEC Guide 25 - General Requirements for the Competence of Calibration and Testing Laboratories.

1.3 SELECTION AND PAYMENT

- A. The Authority will select, employ, and pay for services of an independent testing laboratory to perform inspection and testing identified in Part 3 of individual Specification sections.
- B. Contractor shall employ and pay for services of an independent testing laboratory or laboratories to perform inspection and testing identified in Part 2 of individual Specification sections.
- C. Employment of a testing laboratory by the Authority shall not relieve Contractor of its obligation to perform work in accordance with requirements of Contract documents.
- D. The Authority will deduct a minimum two-hour charge for testing laboratory time from periodic progress payment when operations requiring testing or inspection are canceled

without prior notification.

- E. The Authority will deduct cost of retesting from periodic progress payment whenever failed work is removed, replaced and retested.
- F. Resident Project Representative (RPR) schedules and monitors testing. Provide 24 hours notice of testing to Project Representative to avoid delay of the Work.

1.4 QUALIFICATION OF LABORATORY

- A. Meet laboratory requirements of ASTM E 329 and applicable requirements of ASTM C 1077, ASTM D 3666, and ASTM D 3740.
- B. Meet ISO/TEC Guide 17025 conditions for accreditation by the American Association for Laboratory Accreditation (A2LA) in specific fields of testing required in individual Specification sections.
- C. If laboratory subcontracts are part of the testing services, such work will be placed with a laboratory complying with the requirements of this Section.
- D. Unless otherwise notified by Engineer, Engineer shall schedule and monitor testing. Provide 24 hours notice of testing to avoid delay of work.

1.5 LABORATORY REPORTS

- A. Testing laboratory shall provide and distribute copies of laboratory reports to the distribution list Engineer provides at the pre-construction conference. These reports will be transmitted via fax, email, or other method selected at the pre-construction conference.
- B. Keep one copy of each laboratory report distributed or transmitted at the site field office for duration of the Work.
- C. Laboratory will transmit reports that indicate failing test results to the material supplier, Contractor and Engineer by no later than close of business on the working day following test completion and review.

1.6 LIMITS ON TESTING LABORATORY AUTHORITY

- A. Laboratory may not release, revoke, alter, or enlarge requirements of the Contract.
- B. Laboratory may not approve or accept any portion of the Work.
- C. Laboratory may not assume Contractor duties.
- D. Laboratory has no authority to stop the Work.

1.7 CONTRACTOR RESPONSIBILITIES

- A. Provide safe access to the Work and to manufacturer's facilities for Engineer and for testing laboratory personnel.
- B. Provide testing laboratory with a copy of the Construction Schedule and a copy of each update to Construction Schedule.
- C. Notify Engineer and testing laboratory during normal working hours of the day previous to expected time for operations requiring inspection and testing services. When Contractor fails to make timely prior notification, do not proceed with the operations requiring inspection and testing services.
- D. Notify Design Professional of Record minimum 24 hours in advance when Specification requires presence of Design Consultant for sampling or testing.
- E. Request and monitor testing as required to provide timely results and to avoid delays to the Work. Provide samples to laboratory in sufficient time to allow required test to be performed in accordance with specified test methods before intended use of the Product.
- F. Cooperate with laboratory personnel in collecting samples on site. Provide incidental labor and facilities for safe access to the Work to be tested, to obtain and handle samples at site or at source of Products to be tested, and to facilitate tests and inspections including storage and curing of test samples.
- G. Make arrangements with laboratory through Engineer. Payment for additional testing will be made in accordance with the General Conditions of the Construction Contract:
 - 1. Re-testing required for failed tests.
 - 2. Re-testing for nonconforming work.
 - 3. Additional sampling and tests requested beyond specified requirements.
 - 4. Insufficient notification of cancellation of tests for work scheduled but not performed.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.01 CONDUCTING TESTING

- A. Conform to laboratory sampling and testing methods specified in individual Specification sections to the latest issues of ASTM standards, TxDOT methods, or other recognized test standards as approved by Engineer.
- B. Requirements of this Section shall also apply to those tests for approval of materials, for mix designs, and for quality control of materials as performed by employed testing laboratories.

END OF SECTION

Section 01502

MOBILIZATION

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Mobilization of construction equipment and facilities onto the site.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price Contracts. If Contract is Unit Price Contract, measurement for mobilization is on a lump sum basis.
- B. Stipulated Price (Lump Sum) Contract. If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.
- C. Mobilization payments will be included in monthly payment estimates upon written application by Contractor subject to the following provisions:
 - 1. Authorization for payment of 50 percent of that portion of Contract Price designated for mobilization will be made upon receipt and approval by Engineer of the following items, as applicable:
 - a. Schedule of Values (Section 01292).
 - b. Pre-Construction site assessment, Construction Photographs or Videos (Section 01321), as required.
 - c. Construction Schedule and Billing Forecast (Section 01325/01326 as applicable).
 - d. Submittal Schedule (Section 01330).
 - e. Site specific Storm Water Pollution Prevention Plan (SWPPP) and Notice of Intent (NOI) along with storm water application fee (Section 01410), if required.
 - f. Contractor's Quality Control Plan (Section 01450), if required.
 - g. Establishment of a Field Office for Engineer meeting requirements of Section 01520 - Temporary Field Office.

- h. Traffic Control Plan (Section 01555), if required.
 - i. Plan for Control of Ground and Surface Water (Section 01578), if required.
 - j. Project Signs Submittal (Section 01580).
 - k. Trench Safety Program (Section 02260), if required.
 - l. Dewatering plan, when required.
- 2. Authorization for payment of the balance of that portion of Contract Price designated for mobilization will be made upon completion of the Work amounting to five percent of Original Contract Price. The amount of Contract Price designated for mobilization may not be applied in computing whether or not five percent of the Original Contract Price has been obtained.
- 3. Mobilization payments will be subject to retainage amounts stipulated in the General Conditions of the Construction Contract.
- D. De-Mobilization/Re-Mobilization for project delaying items are included in the bid items for each of the Levels identified in this Section. Authorization for payment of 50 percent of that portion will be made after completely demobilizing from the site including, but not limited to securing the site, temporary restoration, and removal of construction equipment, personnel and construction materials. Authorization for payment of the remaining cost will be made after all construction equipment and materials are transported back to the construction site. Payment for the above will only be granted once and must be approved by Engineer.
- E. Relocation of Work area as needed to comply with the requirements of the Migratory Bird Treaty Act (See Specification Section 01565) will be directed by Engineer at no separate pay. Work may continue in the vacated area at the end of the breeding season for migratory birds and/or the winter season for bald eagles.

1.3 DE-MOBILIZATION AND RE-MOBILIZATION:

- A. De-Mobilization/Re-Mobilization to be used at the direction of the Engineer. Contractor shall discontinue Work and return at a later date to complete the Work. Contract Time will be suspended during the demobilized period, or additional time may be added to the Contract for the demobilized period, including time to temporarily restore the site, remove equipment, and to re-mobilize. Some Unit Price Items, identified in Exhibit 1, the Contractor's Bid, may have to be repeated (e.g. Groundwater Control). These repeated work items shall be paid under their respective Unit Price Items for the appropriate number of times the Work is performed. Contractor shall notify the Engineer which items are anticipated to be repeated upon notice of de-mobilization and work conscientiously to minimize the repeated work.

Payment also includes the effort to Re-mobilize, as directed by Engineer, following the demobilized period of time. All equipment and materials, including traffic control, should be returned to the site and temporary restoration measures shall be removed.

De-mobilization/Re-mobilization may be required at different phases of the project. The Level of De-mobilization/Re-mobilization used, if required, shall be according to the following descriptions at the direction of the Engineer:

1. Level 1: No Pipe laying work has begun in the area to be vacated

- a. Remove equipment, materials, waste products, temporary facilities, storage boxes, and other resources from the site.
- b. Temporarily backfill open trenches and excavation locations. Backfill shall comply with applicable specifications, including type of materials and compaction requirements.
- c. Reopen roads, driveways, sidewalks and other public facilities. Temporary restoration measures shall comply with applicable Federal, State and city regulatory requirements. Temporary restoration shall include, but not be limited to, temporary asphalt, pavement striping, traffic control signage and street signage.
- d. Remove temporary traffic control from project site area.
- e. Maintain coordination with the rescheduling of proposed Work with Engineer and sub-contractors.
- f. Re-mobilize at the direction of the Engineer within 30 days of notification.

2. Level 2: Pipe Laying Work has begun in the area to be vacated

- a. Coordinate with Engineer for the level of completion to attain before stopping Work.
- b. Cap end of pipe with plastic cover and brace with timber or other material adequate to prevent fill from entering pipe. Backfill pipe in compliance with applicable specifications.
- c. Remove equipment, materials, waste products, temporary facilities, storage boxes, and other resources from the site.
- d. Temporarily backfill open trenches and excavation locations. Backfill shall comply with applicable specifications, including type of materials and compaction requirements.
- e. Reopen roads, driveways, sidewalks and other public facilities. Temporary restoration measures shall comply with applicable Federal, State and city regulatory

requirements. Temporary restoration shall include, but not be limited to, temporary asphalt, pavement stripping, traffic control signage and street signage.

- f. Remove temporary traffic control from project site area.
- g. Maintain coordination with the rescheduling of proposed Work with Engineer and sub-contractors.
- h. Re-mobilize at the direction of the Engineer within 30 days of notification.

3. Level 3: During preparation of water line for hydrostatic testing or disinfection.

- a. De-mobilize if unable to begin filling the water line within 14 days of being notified as required in Specification Sections 02514 and 02515. Coordinate with Engineer for the level of completion to attain before stopping Work.
- b. Secure all disinfection and de-chlorination chemicals.
- c. Secure all blow-off and manhole locations.
- d. Secure any open excavations.
- e. Re-mobilize at the direction of the Engineer within 10 days of notification.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01504

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary facilities and necessary controls for the Project, including utilities, telephone, sanitary facilities, storage sheds and building, safety requirements, first aid equipment, fire protection, security measures, protection of the Work and property, access roads and parking, environmental controls, pest and rodent control and disposal of trash, debris and excavated material.
- B. Facilities and controls specified in this section are considered minimum for the Project. Provide additional facilities and controls for proper execution of the Work and to meet Contractor's responsibilities for protection of persons and property.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. No separate payment will be made for any temporary facilities and controls required under this section. Include cost of such work in contract price listed for mobilization.

1.3 CONTRACTOR'S RESPONSIBILITY

- A. Comply with applicable requirements specified in other sections of Specifications.
 - 1. Maintain and operate temporary facilities and systems to assure continuous service.
 - 2. Modify and extend systems as the Work progress requires.
 - 3. Completely remove temporary materials and equipment when no longer required.
 - 4. Restore existing facilities used for temporary services to specified or original condition.

PART 2 PRODUCTS - NOT USED

PART 3 E X E C U T I O N

3.1 TEMPORARY UTILITIES

A. Obtaining Temporary Service:

1. Make arrangements with utility service companies for temporary services.
2. Abide by rules and regulations of the utility service companies or authorities having jurisdiction.
3. Be responsible for utility service costs until Date of Substantial Completion. Included are fuel, power, light, heat, and other utility services necessary for execution, completion, testing, and initial operation of work.

B. Water:

1. Provide water required for and in connection with work to be performed and for specified tests of piping, equipment, devices, or for other use as required for proper completion of the Work.
2. Provide and maintain an adequate supply of potable water for domestic consumption by Contractor personnel, Engineer and representatives of the Authority.

C. Electricity and lighting:

1. Provide electric power service required for the Work including required testing, lighting, operation of equipment, and other Contractor use.
2. Electric power service includes temporary power or generators required to maintain plant operations during scheduled shutdowns.
3. Minimum lighting level shall be 10 foot-candles for open areas; 20-foot-candles for stairs and shops. Provide a minimum of one 300-watt lamp for each 200 square feet of work area.

D. Temporary Heat and Ventilation:

1. Provide temporary heat necessary for protection or completion of the Work.
2. Provide temporary heat and ventilation to assure safe working conditions; maintain enclosed areas at a minimum of 50 degrees F.

E. Telephone:

1. Provide emergency telephone service at Project site for use by Contractor personnel and others performing work or furnishing services at the site.
2. Provide Houston-Metro lines, allowing unlimited calls, without charge in Greater Houston Metropolitan area with "call waiting" and "call forwarding" options. Provide one telephone answering machine with beeperless remote message retrieval capability.

F. Sanitary Facilities:

1. Provide and maintain sanitary facilities for persons on the site; comply with regulations of State and local departments of health.
2. Enforce use of sanitary facilities by construction personnel at site. Enclose sanitary facilities. Pit-type toilets are not permitted. No discharge will be allowed from these facilities. Collect and store sewage and waste so as not to cause nuisance or health problems. Haul sewage and waste off-site and properly dispose in accordance with applicable regulations.
3. Locate toilets near the Work site and secluded from view insofar as possible. Keep toilets clean and supplied throughout the course of the Work.

3.2 STORAGE SHEDS AND BUILDINGS

- A. Provide adequately ventilated, watertight storage facilities with floor above ground level for Products susceptible to weather damage.
- B. Storage of Products not susceptible to weather damage may be on blocks off the ground.
- C. Store Products in a neat and orderly manner. Place Products to permit easy access for identification, inspection and inventory.
- D. Fill and grade site for temporary structures to provide drainage away from temporary and existing buildings.

3.3 SAFETY REQUIREMENTS

- A. Submit a safety program at the pre-construction meeting and follow the program in accordance with the General Conditions of the Construction Contract. Include documented response to trench safety requirements of Section 02260 - Trench Safety System.

- B. Conduct operations in strict accordance with applicable Federal, State and local safety codes and statutes and with good construction practice. Establish and maintain procedures for safety of all work, personnel and equipment involved in the Work.
- C. Observe and comply with Texas Occupational Safety Act (Art. 5182a, V.C.S.) and with all safety and health standards promulgated by Secretary of Labor under Section 107 of Contract Work Hours and Standards Act, published in 29 CFR Part 1926 and adopted by Secretary of Labor as occupational safety and health standards under Williams-Steiger Occupational Safety and Health Act of 1970, and to other legislation enacted for safety and health of Contractor employees. Safety and health standards apply to Subcontractors and Suppliers as well as to the Contractor.
- D. Observance of and compliance with safety regulations is Contractor's responsibility without reliance or superintendence of or direction by Engineer. Immediately advise Engineer of investigation or inspection by Federal Safety and Health inspectors of Contractor's or Subcontractor's work or place of work on site under the Contract, and after investigation or inspection, advise Engineer of results. Submit one copy of accident reports to Engineer within 10 days of occurrence.
- E. Protect areas occupied by workmen using the best available devices for detection of lethal and combustible gases. Test devices frequently to assure functional capability. Constantly observe infiltration of liquids into the Work area for visual or odor evidence of contamination, and immediately take appropriate steps to seal off entry of contaminated liquids to the Work area.
- F. Implement safety measures, including but not limited to safety personnel, first-aid equipment, ventilating equipment and other safety equipment specified or detailed on Drawings.
- G. Maintain required coordination with Authority, Police, and Fire Departments during entire period covered by the Contract.
- H. Include Project safety analysis in safety plan. Itemize major tasks and potential safety hazards. Plan to eliminate hazards or protect workers and public from each hazard.

3.4 FIRST AID EQUIPMENT

- A. Provide a first aid kit throughout the construction period. List telephone numbers for physicians, hospitals, and ambulance services in each first aid kit.
- B. Have at least one person thoroughly trained in first aid and CPR procedures present on the site when work is in progress. Contractor to conform to protocols and requirements for training and protection against "blood borne pathogens".

3.5 FIRE PROTECTION

- A. Conform to specified fire protection and prevention requirements established by Federal, State, or local governmental agencies and as provided in Safety Program.

3.6 SECURITY MEASURES

- A. Protect the Work, materials, equipment, and property from loss, theft, damage, or vandalism. Protect Authority property used in performance of the Contract.
- B. If existing fencing or barriers are breached or removed for purposes of construction, provide and maintain temporary security fencing equal to existing.

3.7 PROTECTION OF UTILITIES AND PIPELINES

- A. Prevent damage to existing public utilities during construction. Approximate locations of known utilities are shown on Drawings, but all lines may not be shown. Excavate with caution and repair lines damaged by construction operations.
- B. Use the Utility Coordinating Committee One Call System, telephone number, (713) 223-4567, which must be called 48 hours in advance. The toll free telephone number is 1-800-669-8344, Texas One Call System.
- C. Before excavating, locate underground utilities by appropriate means including the use of metal detection equipment, and probes, or by excavation or surveys. Repair damage caused by investigative work and by failure to locate or to preserve underground utilities.
- D. Give utility owners a minimum five-day notice before commencing excavation to allow time to locate utilities and make adjustments or relocations when they conflict with the Work. Include cost for temporary relocation of water, wastewater, and storm drainage lines, necessary to accommodate construction, in unit prices for utility construction unless otherwise noted. Bypassing of sanitary waste to storm drainage facilities is not allowed.
- E. Prior to excavation near pipelines, request a representative of the pipeline company to meet with Contractor and Engineer at the site to discuss procedures to be used. Request pipeline company's representative to locate the pipelines in at least three locations: at each side and at centerline of proposed excavation of proposed utility. Also request representative and Engineer to be present to observe Contractor operations when excavation is conducted within 15 feet of pipeline.
- F. Utility service lines are not shown on the construction document drawings. Contractor should anticipate that such service lines exist and should exercise extreme caution during construction. The utility service lines should be repaired and restored immediately as per the specification, if damaged due to any construction activities. No separate payment will be made for this repair and restoration work. Include payment in unit price for work in appropriate sections.

- G. Prior to abandonment of utility, make appropriate arrangements with Authority and owner of utility to terminate service, remove meters, transformers, and poles as may be required by site conditions.

3.8 PROTECTION OF THE WORK AND PROPERTY

A. Preventive Actions

1. Take necessary precautions and actions to prevent damage, injury, or loss to the Work or public and private property, including:
 - a. Storage of apparatus, supplies, and Products in an orderly, safe manner to limit interference with progress of the Work or work of other contractors, utility service companies, or the Authority's operations.
 - b. Suitable storage for Products subject to damage by exposure to weather, theft, breakage, etc.
 - c. Limitation of loading pressures imposed upon portions of the Work.
 - d. Frequent cleanup of refuse, scrap materials, and debris from construction operations, necessary to maintain the site in a safe and orderly condition.
 - e. Provision of barricades and guard rails to protect pedestrian and traffic around openings, scaffolding, temporary stairs and ramps, excavations, elevated walkways, and other hazardous areas.
2. Protect public and private property adjacent to the site. Obtain written consent before entering or occupying privately-owned land except on easements provided for construction. Restore property damaged by construction operations to condition equal to or better than that existing before the damage.

B. Barricades and Warning Systems

1. Where work is performed on or adjacent to roadways, rights-of-ways, or public land, provide barricades, fences, lights, warning signs, danger signals, and other precautionary measures necessary for protection of persons or property and for protection of the Work.
 - a. Erect sufficient barricades to keep vehicles and pedestrians from entering the Work. Paint barricades to be visible at night.
From sunset to sunrise, provide at least one light at each barricade.

- b. Maintain barricades, signs, lights, and provide watchmen until Engineer approves removal. Whenever work creates encroachment onto public roadways, station flagmen to manage traffic flow in accordance with approved traffic control plan.
 - c. Conform to requirements of section 01555 – Traffic Control and regulation.
- C. Protection of Existing Structures
 - 1. Underground Facilities
 - a. Known Underground Facilities are shown on the Drawings but all Facilities may not be shown. Explore sufficiently ahead of trenching and excavation work to locate Underground Facilities in order to prevent damage to them and to prevent interruption of utility services. Restore damage to Underground Facilities to original condition at no additional cost to the Authority.
 - b. If necessary to avoid unanticipated Underground Facilities, Engineer may make changes in location of the Work.
 - c. If permanent relocation of an Underground Facility is required and not provided for in the Contract documents, DPOR will direct Contractor in writing to perform the Work under Modification provisions in the General Conditions of the Construction Contract.
 - 2. Surface Structures include buildings, tanks, walls, bridges, roads, dams, channels, open drainage, piping, poles, wires, posts, signs, markers, curbs, walks, guard cables, fencing, and other facilities that are visible above the ground level.
 - 3. Protection of Underground Facilities and Surface Structures:
 - a. Support in place and protect Underground Facilities and Surface Structures located within or adjacent to the limits of the Work from damage. Install supports as required by the owner of the structure. Satisfy Engineer that the owner of the facility or structure has approved methods and procedures before installing structure supports.
 - b. Avoid moving or changing public utility or private corporation property without prior written consent of a responsible official of the facility or structure. Allow representatives of utilities to enter the construction site for maintenance and repair purposes or to make necessary changes.

- c. Notify utility and pipeline owners and operators of the nature of construction operations and dates when operations will be performed. When construction operations are required in immediate vicinity of existing structures, pipelines, or utilities, give a minimum of five working days advance notice. Probe and flag location of Underground Facilities prior to commencement of excavation. Keep flags in place until construction operations uncover the facility.
 - d. Assume risk for damages and expenses to Underground Facilities and Surface Structures within or adjacent to the Work.
- D. Employ a structural engineer to ensure protection measures are adequate for the safety and integrity of structures and facilities.
- E. Protection of Installed Products:
 - 1. Provide protection of Installed Products to prevent damage from subsequent operations. Remove protection facilities when no longer needed, prior to completion of the Work.
 - 2. Control traffic to prevent damage to Products and surfaces.
 - 3. Provide coverings to protect Products from damage. Cover projections, wall corners, jambs, sills, and exposed sides of openings in areas used for traffic and passage of materials in subsequent work.

3.9 ROADS AND PARKING

- A. Prevent interference with traffic and operations of the Authority on existing roads.
- B. Designate temporary parking areas to accommodate construction and Authority personnel. When site space is not adequate, provide additional off-site parking. Locate as approved by Engineer.
- C. Minimize use by construction traffic on existing streets and driveways.
- D. Do not allow heavy vehicles or construction equipment in existing parking areas.

3.10 ENVIRONMENTAL CONTROLS

- A. Use methods, equipment, and temporary construction necessary for control of environmental conditions at the site and adjacent areas.
- B. Comply with statutes, regulations, and ordinances relating to prevention of environmental pollution and preservation of natural resources including National Environmental Policy Act of 1969, PL 91-190, Executive Order 11514.

- C. Minimize impact to the surrounding environment. Do not use construction procedures that cause unnecessary excavation and filling of terrain, indiscriminate destruction of vegetation, air or stream pollution, or harassment or destruction of wildlife.
- D. Limit disturbed areas to boundaries established by the Contract. Do not pollute on-site streams, sewers, wells, or other water sources.
- E. Do not burn rubbish, debris or waste materials.

3.11 POLLUTION CONTROL

- A. Provide methods, means, and facilities necessary to prevent contamination of soil, water or the atmosphere by discharge of Pollutants from construction operations.
- B. Provide equipment and personnel to perform emergency measures to contain spillage, and to remove contaminated soils or liquids. Excavate and dispose of contaminated earth off-site in accordance with laws and regulations, and replace with suitable compacted fill and topsoil.
- C. Provide systems necessary for control of Pollutants.
 - 1. Prevent toxic concentrations of chemicals.
 - 2. Prevent harmful dispersal of Pollutants into the environment.
- D. Use equipment that conforms to current Federal, State, and local laws and regulations.

3.12 PEST AND RODENT CONTROL

- A. Provide rodent and pest control as necessary to prevent infestation of construction or storage areas.
- B. Employ methods and use materials that will not adversely affect conditions at site or on adjoining properties.

3.13 NOISE CONTROL

- A. Provide vehicles, equipment, and use construction activities that minimize noise to the greatest degree practicable. Conform to noise levels of Chapter 30 –Noise and Sound Level Regulation, City Code of Ordinances, and latest OSHA standards. Do not permit noise levels to interfere with the Work or create a nuisance to surrounding areas.
- B. Conduct construction operations during daylight hours except as approved by Engineer.

- C. Select construction equipment that operates with minimum noise and vibration. When directed by Engineer, correct objectionable noise or vibration produced by operation of equipment at no additional cost to the Authority. Sound Power Level (PWL) of equipment shall not exceed 85 dbA (re: 10^{-12} watts) measured five feet from the equipment, or at a lower level if prescribed by City Ordinances. Equipment noise requirements are contained in equipment specifications.

3.14 DUST CONTROL

- A. Use water or other methods approved by Engineer to control amount of dust generated by vehicle and equipment operations.

3.15 WATER RUNOFF AND EROSION CONTROL

- A. Comply with requirements of section 01410 – TPDES Requirements.
- B. Conduct fill, grading and ditching operations and provide adequate methods necessary to control surface water, runoff, subsurface water, and water from excavations and structures in order to prevent damage to the Work, the site, or adjoining properties.
 - 1. Plan and execute construction and earthwork by methods that control surface drainage from cuts and fills, and from borrow and waste disposal areas.
 - 2. Minimize area of bare soil exposed at one time.
 - 3. Provide temporary control measures, such as berms, dikes, and drains.
 - 4. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
 - 5. Construct fill and waste areas by selective placement of materials to eliminate erosion of surface silts or clays that may erode.
 - 6. Direct water away from excavations, pits, tunnels, and other construction areas to prevent erosion, sedimentation or damage.
 - 7. Maintain existing drainage patterns adjacent to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover.
 - 8. Dispose of drainage water in a manner to prevent flooding, erosion, or other damage to the site or adjoining areas, in conformance with environmental requirements.

9. Inspect earthwork periodically to detect any evidence of erosion. Take corrective measures as required to control erosion.

END OF SECTION

Section 01506

DIVERSION PUMPING

PART 1 G E N E R A L

1.1 DEFINITIONS

- A. Diversion-pumping: Installation and operation of bulkheads, plugs, hoses, piping, and pumps required to maintain sewer flow and prevent backups and overflows.

1.2 SYSTEM DESCRIPTION

- A. Provides continuous sewer service to users of sewer systems while maintenance or construction operations are in progress, by diverting flow around construction locations. Maintain sewer flow to prevent backup or overflow onto streets, yards and unpaved areas or into buildings, adjacent ditches, storm sewers, and waterways. Do not divert sewage outside of sanitary sewer system.
- B. When pumps are operating, have an experienced operator on site to monitor operation, adjust pumps, make minor repairs to system, and report problems.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittals Procedures.
- B. For systems that bypass sanitary sewer line segments of 42-inch diameter or larger, submit a Diversion Pumping Plan prior to installation. Show location, number and size of pumps, number, location, size and type of hoses or rigid piping, and location of downstream discharge; and special features where pipes or hoses cross roadways, temporary trenches, support bridges.

1.4 SCHEDULING

- A. When the Authority operates or maintains diversion pumping in construction areas, coordinate construction activities with Engineer.
- B. Cease operation of diversion pumping when approved by Engineer.

1.5 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for diversion pumping, unless noted on bid form, including bulkheads, plugs, piping, and pumping equipment, required for replacement of existing sanitary sewers.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Design piping, joints and accessories to withstand at least twice maximum system pressure or 50 psi, whichever is greater.
- B. Use self-priming type or submersible electric pumps, with a working pressure gauge on the discharge. Pumps shall meet requirements of City of Houston Noise and Sound Level Regulations.

PART 3 E X E C U T I O N

3.1 FIELD QUALITY CONTROL

- A. During diversion pumping, do not allow sewage to leak, dump, or spill into or onto areas outside of existing sanitary sewer systems.
- B. In the event of an accidental spill or overflow, immediately stop discharge and take action to clean up and disinfect spill. Promptly notify Engineer so required reporting can be made to the Texas Commission on Environmental Quality (TCEQ) and the Environmental Protection Agency (EPA).

3.2 CLEANING

- A. When diversion-pumping operations are complete, drain sewage within piping into sanitary sewers prior to disassembly.

END OF SECTION

Section 01520

TEMPORARY FIELD OFFICE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Temporary field office building and associated parking area.

1.2 FACILITY DESCRIPTION

- A. Temporary field office to be utilized by authorized representatives of the Authority to coordinate and monitor daily construction activities performed by Contractor.
- B. Field office shall be a non-smoking facility.

PART 2 P R O D U C T S

2.1 FIELD OFFICE

A. General:

- 1. Locate office in vicinity of the Work at a location approved by Engineer or where indicated on Drawings.
- 2. Furnish, Install and maintain field office for exclusive use of authorized representatives of the Authority. Provide sufficient room for Project meetings and Resident Project Representative's (RPR's) office. Provide 2 trailers with minimum area of 600 square feet per trailer.
- 3. Provide office within 10 days of Date of Commencement of the Work.
- 4. Construct ten all-weather, hard surfaced parking spaces for exclusive use of authorized representatives of the Authority. Provide all-weather surfaced walk between parking spaces and field office.

B. Minimum Construction:

- 1. Structurally sound foundation and superstructure.
- 2. Weather tight with insulated roof, walls and 7-foot ceiling (minimum).

3. Stairs or walkway with handrail and covered entrance platform (minimum 4 feet by 4 feet) with mud scraper at door.
 4. Resilient floor covering.
 5. Screened windows with area equal to approximately 10 percent of floor area sufficient for light, view of the site, and ventilation. Provide each window with operable sash and burglar bars.
 6. Secure exterior doors with dead-bolt cylinder locks and burglar bars.
- C. Minimum Services: (per provided trailer)
1. Exterior entrance light.
 2. Interior lighting of 75 foot-candles minimum at desktop height
 3. Automatic heating to maintain 65 degrees F in winter.
 4. Automatic cooling to maintain 75 degrees F in summer.
 5. Electric power service.
 6. One telephone service line for voice for exclusive use of authorized representatives of the Authority.
 7. Sanitary facilities in field office with one water closet, one lavatory, and one medicine cabinet for exclusive use of authorized representatives of the Authority.
 8. Internet access with wireless internet capabilities. Provide service with minimum download speed of 50 megabits per second (Mbps) or greater.
- D. Minimum Furnishings: (per provided trailer)
1. One 5-drawer desk
 2. Two swivel desk chairs with casters.
 3. One plan table.
 4. One drawing plan rack.
 5. One 4-drawer legal file cabinet complete with fifty legal-size hanging folders and two full-sized carriers.
 6. One marker board with cleaner and markers.

7. Two waste baskets.
 8. One 30-inch by 36-inch tack board.
 9. One all-purpose fire extinguisher.
 10. Six protective helmets (hard hats) with ratchet adjustment for exclusive use of authorized representatives of the Authority.
 11. Conference table and chairs to accommodate 20 persons.
 12. All in one wireless printer, copier, scanner, including capability to scan 8.5-inch x 14-inch and 11-inch x 17-inch documents.
 13. Telephone with speaker-phone/conference call capabilities
 14. Refrigerator with minimum capacity of 6 cubic feet.
 15. Water dispenser or adequate supply of water bottles for WHCRWA on-site staff.
- E. Provide adequate space for one set of Contract documents for ready reference.

PART 3 EXECUTION

3.1 MAINTENANCE

- A. Maintain all-weather surface driveway and parking areas, buildings, walkways, stairs and required furnishings and equipment for duration of the Contract.
- B. Provide janitorial services for duration of the Contract consisting of twice weekly sweeping and mopping floors, trash removal, weekly restroom cleaning, and weekly dusting of furniture and equipment.
- C. Provide soap, paper towels, toilet paper, cleansers, printer paper, printer ink, and other necessary consumables.
- D. Immediately repair damage, leaks or defective service.

3.2 PROJECT CLOSEOUT

- A Remove temporary field office and signs and restore site as specified in Section 01770 - Closeout Procedures.

END OF SECTION

SECTION 01554

TRAFFIC CONTROL AND STREET SIGNS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials, hardware and installation of Traffic Signs.

1.2 SUBMITTALS

- A. Contractor shall submit a list of intended suppliers and products to be used for all signs, posts, and associated hardware. Authority reserves the right to request actual product samples prior to approval.

1.3 MEASUREMENT AND PAYMENT

- A. Signs installed or replaced will be measured by each sign. Signs refurbished will be measured by each sign.
- B. Payment for installation of traffic signs will be on the basis of each sign installed.
- C. The price is full compensation for furnishing and installing new signs and hardware. Cost of associated posts, footings, and miscellaneous mounting hardware will not be paid for directly but is to be included in the unit price bid for installation of each traffic sign.
- D. Non-standard signs installed or replaced will be measured by the square foot of the sign face. Non-standard signs shall not be installed without prior approval from the Authority.

PART 2 PRODUCTS

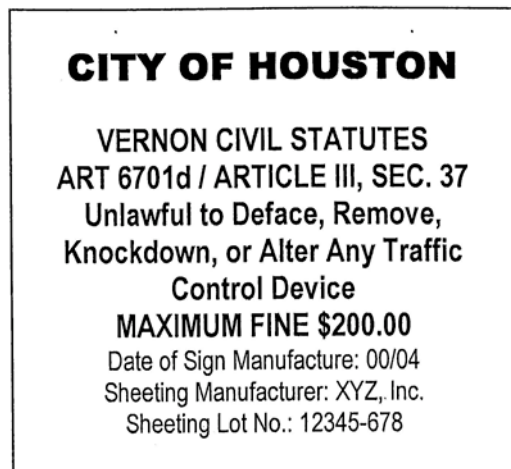
2.1 MATERIALS

- A. The following ASTM Standards and documents, of the issue in effect on the date of Invitation for Bid, form a part of this specification to the extent herein.
 - 1. ASTM B 209 Specification for Aluminum and Aluminum Alloy Sheet and Plate
 - 2. ASTM D 523 Standard Method for Test for Specular Gloss

3. ASTM D 4956 Standard Specification for Retroreflective Sheeting for Traffic Control
 4. ASTM E 284 Standard Definition of Terms Relating to Appearance of Materials
 5. ASTM E 308 Computing the Colors of Objects by Using the CIE System
 6. ASTM E 810 Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting
 7. ASTM E 1164 Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation
- B. Substrate (Sign Blanks). This shall be aluminum alloy 5052-H38 and otherwise in conformance with ASTM B-209 and have gold chromate finish. The size, shape and thickness of the sign blanks are as indicated on the standard detail sheet in the plans or as specified by the Design Professional of Record (DPOR).
1. Metal working. The aluminum shall be free of burrs and pits on both sides, including edges and holes, and shall be made ready for applications of the sheeting.
 2. Surface Preparation. The aluminum shall be thoroughly cleaned and degreased with solvent and alkaline emulsions cleaner by immersion, spray, or vapor degreasing and dried prior to application of the gold chromate sheeting coat. The aluminum shall be new and corrosion-free with holes drilled or punched, corners rounded to the radii shown in the standard detail sheet, and all edges smoothed prior to application of sheeting. The heavy or medium chromate coating shall conform in color and corrosion resistance to that imparted by the Alodine 1200F treatment.
 3. Size. The dimensions of substrate applications for regulatory, warning, and guide signs shall be as specified by the Design Professional of Record and as shown on the plans.
- C. Sign Face (Background, Legends, Symbols, and Colors). These shall be in accordance with the Standard Highway Sign Designs (SHSD) for Texas and with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).
1. The sign face, made of electronic film and retro-reflective sheeting shall comply with the appearance, specification, and good workmanship designated by the using agency for sign faces constructed of screen processed retro-reflective sheeting of the same type.

2. All sign blanks shall be covered with appropriate retro-reflective sheeting.
 - a. All ground mounted stop signs, warning signs, and other regulatory signs, shall use at a minimum High Intensity Prismatic Reflective Sheeting.
 - b. All overhead signs shall use Diamond Grade Reflective Sheeting.
 - c. All other signs shall use Super Engineer Grade Sheeting
 3. Application Methods. The method of application of sheeting, letters, numbers, and symbols shall be precisely as prescribed in writing by the manufacturer.
 - a. Legend Spacing and Layout. Spacing and layout for all traffic control signs shall conform to the SHSD.
 - b. Tolerance for Horizontal Alignment. Letters, numerals, and symbols shall be horizontally aligned to a tolerance of 1/16 inch.
 - c. Tolerance for Vertical Alignment. Letters, numerals, and symbols shall be vertically aligned to a tolerance of 1/16 on each letter in each line.
- D. Sign Posts. Steel post shall conform to the standard specification for hot rolled carbon sheet steel, structural quality, ASTM designation A570, Grade 50. Average minimum yield strength after cold forming is 60,000 psi. The cross section of the post shall be square tube formed steel, carefully rolled to size and shall be welded directly in the corner by high frequency resistance welding or equivalent process and externally scarified to agree with corner radii. Sign posts shall be hot dipped galvanized conforming to ASTM A653, G90.
1. Installation. The square end of the post shall not be modified or pointed.
 - a. Flange. When sign post installation is required over building basements, bridges and cavities, a galvanized cast iron pipe flange shall be used. The base shall be 8 inches in diameter with six 5/16 inch holes drilled equidistant around the circumference, 5/8 inch from the outer edge. The neck of the flange shall be 3 inches in diameter, drilled and threaded to receive a 2 inch diameter galvanized post.
 - b. Hardware. All ground mounted signs shall be attached to posts using 5/16" nut and bolt assembly, the bolt being 2 1/2" in length. Stainless steel banding material, brackets and clips will be used for signs installed on light standards or mast arms.

- c. Construction. Anchors shall be anchored in a minimum of one cubic foot of class "C" concrete, 28 inches deep, with a 6 inch long, $\frac{3}{8}$ inch diameter pin inserted through the pre-drilled hole 3 inches from the bottom of the pole. Where the pole installation requires surface mounting, an 8 inch flange with a 2 inch threaded collar shall be used. The pole shall be galvanized, two inches in diameter and threaded to fit the flange. Sign placement and orientation shall be as specified in the construction plans.
- E. For signs installed within City of Houston limits, each finished sign shall have the following sticker affixed to the back in a location where it will be visible when the sign is installed:



The sticker shall be Zebra Technologies Z-Ultimate 3000 White or approved equal. Finished product shall be weather and fade resistant for the expected life of the sign.

- F. Warranty. The Contractor shall warrant the materials and workmanship of each sign in accordance with the maximum limits of material warranties extended by manufacturers of raw materials, subject to the conditions they specify. The retro-reflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retro-reflection is less than the minimum specified for that sheeting. When sign failure occurs prior to the minimum years indicated and an inspection demonstrates that the failure is caused by materials warranted to contractor to endure at least that long, the sign will be replaced or repaired free of materials charges. When failure occurs and inspection demonstrates that such failure is due to poor workmanship, the sign will be replaced or repaired at Contractor's expense, including shipping charges.

PART 3 EXECUTION

3.1.1 EQUIPMENT

- A. The contractor shall provide machinery, tools, and equipment necessary for proper execution of the work.

3.1.2 CONSTRUCTION

- A. Construction shall be high quality with no visible defects in the finished product. Fabrication shall be in accordance with these specifications. Street name signs shall always be supplied and installed at each project intersection whether signs previously existed at the location or not.
- B. The removal of existing signs shall be coordinated with the Engineer and arrangements made for a convenient time to deliver Authority signs and poles. All salvaged traffic signs shall be delivered to the Authority. All deliveries require a minimum notice of two (2) working days prior to returning or delivering any sign and/or sign related material.

3.3 RESPONSIBILITIES

- A. The contractor is responsible for providing and supplying aluminum traffic signs covered with retro-reflective sheeting, applying standard legends (or special legends if shown in the plans) to the covered sign blanks, galvanized steel sign poles, pole anchors, all hardware for installing the signs and poles, and for installing traffic signs, poles and anchors as shown in the plans or call for in the contract documents, complete and ready for field installations.

END OF SECTION

Section 01555

TRAFFIC CONTROL AND REGULATION

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Requirements for signs, signals, control devices, traffic barriers, flares, lights and traffic signals; construction parking control, designated haul routes, and bridging of trenches and excavations.
- B. Qualifications and requirements for use of flagmen.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price Contracts.
 - 1. Traffic control and regulation. Payment for traffic control and regulation is on a lump sum basis. Include preparation and submittal of traffic control plan if different than shown on Drawings, and provision of traffic control devices, equipment, and personnel necessary to protect the Work and public. Payment will be based on Contractor's Schedule of Values for traffic control and regulation.
 - 2. Payment for traffic control will be authorized by Engineer in three (3) parts. Partial payment will be made according to following schedule:
 - a. Payment of 25 percent of traffic control amount will be authorized when permanent control devices and necessary temporary markings, sufficiently deployed along job site as required to maintain progress of work, are installed at job site and approved. This limiting percentage will be prorated based upon extent of Contractor's setup.
 - b. A payment of 50 percent of traffic control amount will be authorized when pavement replacement commences. This limiting percentage will be prorated based upon linear footage, as measured along centerline axis of water main, of pavement replaced.
 - c. A payment of 25 percent of traffic control amount will be authorized when permanent pavement markings are restored and all unnecessary permanent and temporary control devices removed. This limiting percentage will be prorated based upon the extent of restoration.

3. Flagmen: Measurement is on a lump sum basis for flagmen as required for the project. The amount invoiced shall be determined based on the schedule of value submitted for flagmen.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price Contracts. Include payment for work under this section in the total Stipulated Price.

1.3 REFERENCES

A. Texas Manual on Uniform Traffic Control Devices(TMUTCD)

B. Article 4413 (29bb), commonly referred to as Private Investigators and Private Security Agencies Act, and Article 2.12, Texas Code of Criminal Procedure.

C. Code of Ordinances, City of Houston, Texas.

1. Chapter 10 Buildings And Neighborhood Protection, Article X Cleanup After Demolition Or Removal Of Structures

2. Chapter 40 Streets and Sidewalks, Article XVII Pedestrian Way Impairments

1.4 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Traffic control plan:

1. If using traffic control plan contained in the Contract without modification, submit a letter confirming use of the plan.

2. If using a different traffic control plan, submit the plan for approval. The plan must conform to TMUTCD requirements and be sealed by a Registered Texas Professional Engineer.

C. Submit copies of approved lane closure permits.

D. Submit Schedules of Values for traffic control plan and flagmen within 30 days following Notice to Proceed.

E. Submit records verifying qualifications of Uniformed Peace Officers and Certified Flagmen proposed for use on the Work.

1.5 FLAGMEN

- A. Use Uniformed Peace Officers and Certified Flagmen to control movement of vehicular and pedestrian traffic when construction operations encroach on public traffic lanes. Unless otherwise approved by Engineer, use Uniformed Peace Officer for work along major thoroughfares, schools, churches, hospitals and Work at signalized intersections.
- B. Uniformed Peace Officer: Individual employed full-time as a peace officer who receives separate compensation as a privately employed flagman. Private employment may be an employee-employer relationship or on an individual basis. Flagman may not be in the employ of another peace officer nor be a reserve peace officer.
 - 1. Uniformed Peace Officers may be:
 - a. sheriffs and their deputies;
 - b. constables and deputy constables;
 - c. marshals or police officers of an incorporated city, town or village; or
 - d. as otherwise provided by Article 2.12, Code of Criminal Procedure.
 - 2. The Uniformed Peace Officer must be a full-time peace officer, must work a minimum average of 32 paid hours per week, and must be paid a rate not less than the prevailing minimum hourly wage rate set by the federal Wage and Hour Act. The individual must be entitled to vacation, holidays, and insurance and retirement benefits.
- C. Certified Flagman: Individual who receives compensation as a flagman and meets the following qualifications:
 - 1. Formally trained and certified in traffic control procedures.
 - 2. Speaks English. Ability to speak Spanish is desirable but not required.
 - 3. Paid for flagman duty at an hourly rate not less than the wage rate set for Rough Carpenter under the Authority's Wage Scale for Engineering Construction.
- D. Certified Flagmen must wear a distinctive uniform, bright-colored vest, and be equipped with appropriate flagging and communication devices while at the Work site. They must also have in their possession while on duty, a proof of training identification card issued by the appropriate training institute.

PART 2 P R O D U C T S

2.1 SIGNS, SIGNALS, AND DEVICES

- A. Comply with TMUTCD requirements.
- B. Traffic cones and drums, flares and lights: Conform to local jurisdictions' requirements.

2.2 PORTABLE LOW PROFILE CONCRETE BARRIERS

- A. The low profile concrete barrier is a patented design. Information concerning this barrier may be obtained from Texas Transportation Institute, Texas A&M University System, College Station, Texas 77843-3135, (409) 845-1712.

PART 3 E X E C U T I O N

3.1 PUBLIC ROADS

- A. Follow laws and regulations of governing jurisdictions when using public roads. Pay for and obtain permits from jurisdiction before impeding traffic or closing lanes. Coordinate activities with Engineer.
- B. Give Engineer one-week notice before implementing approved traffic control phases. Inform local businesses of impending traffic control activities.
- C. Notify police department, fire department, METRO, and local schools, churches, and businesses in writing a minimum of five business days prior to beginning work.
- D. Maintain 10-foot wide all-weather lanes adjacent to the Work for emergency vehicle use. Keep all-weather lanes free of construction equipment and debris.
- E. Do not obstruct normal flow of traffic from 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. on designated major arterials or as directed by Engineer.
- F. Maintain local driveway access to residential and commercial properties adjacent to work areas at all times. Use all-weather materials approved by Engineer to maintain temporary driveway access to commercial and residential driveways.
- G. Keep streets entering and leaving job site free of excavated material, debris, and foreign material resulting from construction operations in compliance with applicable ordinances.
- H. Remove existing signage and striping that conflict with construction activities or that may cause driver confusion.

- I. Provide safe access for pedestrians along major cross streets.
- J. Alternate closures of cross streets so that two adjacent cross streets are not closed simultaneously.
- K. Do not close more than two consecutive esplanade openings at a time without prior approval from Engineer.

3.2 CONSTRUCTION PARKING CONTROL

- A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and the Authority's operations.
- B. Monitor parking of construction personnel's vehicles in existing facilities. Maintain vehicular access to and through parking areas.
- C. Prevent parking on or adjacent to access roads or in non-designated areas.

3.3 FLARES AND LIGHTS

- A. Provide flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

3.4 HAUL ROUTES

- A. Utilize haul routes designated by authorities or shown on drawings for construction traffic.
- B. Confine construction traffic to designated haul routes.
- C. Provide traffic control at critical areas of haul routes to regulate traffic and minimize interference with public traffic.

3.5 TRAFFIC SIGNS AND SIGNALS

- A. Construct necessary traffic control devices for temporary signals required to complete the Work including loop detectors, traffic signal conduits, traffic signal wiring and crosswalk signals. Notify a minimum of 60 days in advance, the agency concerning control boxes and switchgear. The agency will perform necessary service, programming or adjustments, to signal boxes and switchgear if required during construction.
- B. Install and operate traffic control signals to direct and maintain orderly traffic flow in areas under Contractor's control affected by Contractor's operations. Post notices, signs and traffic controls before moving into next phase of traffic control.

- C. Relocate traffic signs and signals as the Work progresses to maintain effective traffic control.
- D. Unless otherwise approved by Engineer, provide driveway signs with name of business that can be accessed from each crossover. Use two signs for each crossover.
- E. Replace existing traffic control devices in Project area.
- F. Engineer may direct Contractor to make minor adjustments to traffic control signage to eliminate driver confusion and maintain orderly traffic flow during construction at no additional cost to the Authority.

3.6 BRIDGING TRENCHES AND EXCAVATIONS

- A. When necessary, construct bridges over trenches and excavation to permit an unobstructed flow of traffic across construction areas and major drives. Use steel plates of sufficient thickness to support H-20 loading and install to operate with minimum noise.
- B. Shore trench or excavation to support bridge and traffic.
- C. Secure bridging against displacement with adjustable cleats, angles, bolts or other devices when:
 - 1. bridging is placed over existing bus routes,
 - 2. more than five percent of daily traffic is comprised of commercial or truck traffic,
 - 3. more than two separate plates are used for bridging, and
 - 4. when bridge is to be used for more than five consecutive days.
- D. Extend steel plates used for bridging a minimum of 1 foot beyond edges of trench or excavation. Use temporary paving materials such as premix to feather edges of plates to minimize wheel impact on secured bridging.

3.7 REMOVAL

- A. Remove equipment and devices when no longer required.
- B. Repair damage caused by installation.
- C. Remove post settings to a depth of 2 feet.

3.8 TRAFFIC CONTROL, REGULATION AND DIRECTION

- A. Use Flagmen to control, regulate and direct an even flow and movement of vehicular and pedestrian traffic, for periods of time as may be required to provide for public safety and convenience, where:
 - 1. multi-lane vehicular traffic must be diverted into single lane vehicular traffic,
 - 2. vehicular traffic must change lanes abruptly,
 - 3. construction equipment must enter or cross vehicular traffic lanes and walks,
 - 4. construction equipment may intermittently encroach on vehicular traffic lanes and unprotected walks and crosswalk,
 - 5. traffic regulation is needed due to rerouting of vehicular traffic around the Work site, and
 - 6. where construction activities might affect public safety and convenience.
- B. Use of Flagmen to assist in the regulation of traffic flow and movement does not relieve Contractor of responsibility to take other means necessary to protect the Work and public.

3.9 INSTALLATION STANDARDS

- A. Work in other phases shall be permitted, provided 1) phases are not continuous to one work is being done in presently, 2) installation of utility occurs in only one phase. Keep work and operation in second phase to an absolute minimum. Perform work in no more than two phases at a time. Authorization to perform work in second phase shall not relieve any responsibility of completing backfilling and paving operations in accordance with Contract.
- B. Place temporary pavement for single lane closures, in accordance with TMUTCD.
- C. Reinstall temporary and permanent pavement markings as approved by Engineer. When weather conditions do not allow application according to manufacturer's requirements, alternate markings may be considered. Submit proposed alternate to Engineer for approval prior to installation. No additional payment will be made for use of alternate markings.

3.10 MAINTENANCE OF EQUIPMENT AND MATERIAL

- A. Submit name, address and telephone number of individual designated to be responsible for maintenance of traffic handling at construction site to Engineer. Individual must be accessible at all times to immediately correct deficiencies in equipment and materials used to handle traffic including missing, damaged, or obscured signs, drums, barricades, or pavement markings.

- B. Inspect signs, barricades, drums, lamps and temporary pavement markings daily to verify that they are visible, in good working order, and conform with traffic handling plans as approved by Engineer. Immediately repair, clean, relocate, realign, or replace equipment or materials that are not in compliance.
- C. Keep equipment and materials, signs and pavement markings, clean and free of dust, dirt, grime, oil, mud, or debris.
- D. Obtain approval of Engineer to reuse damaged or vandalized signs, drums, and barricades.

END OF SECTION

Section 01562

TREE AND PLANT PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Tree and plant protection.
- B. Minimum qualifications of Arborist and Urban Forester.

1.2 MEASUREMENT AND PAYMENT

- A. Payment for Tree Protection, including tree pruning or tree removal, shall be paid as a Lump Sum basis that shall include all items specified in this section unless payment is specified otherwise in this section.
- B. Refer to Section 01270-Measurement and Payment for unit price procedures.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit name and experience of qualified Arborist, proposed for use on the Work, to Engineer.

1.4 PROJECT CONDITIONS

- A. Preserve and protect existing trees and plants to remain from foliage, branch, trunk, or root damage that could result from construction operations.
- B. Prevent following types of damage:
 - 1. Compaction of root zone by foot or vehicular traffic, or material storage.
 - 2. Trunk damage from equipment operations, material storage, or from nailing or bolting.
 - 3. Trunk and branch damage caused by ropes or guy wires.
 - 4. Root or soil contamination from spilled solvents, gasoline, paint, lime slurry, and other noxious materials.
 - 5. Branch damage due to improper pruning or trimming.

6. Damage from lack of water due to:
 - a. Cutting or altering natural water migration patterns near root zones.
 - b. Failure to provide adequate watering
7. Damage from alteration of soil pH factor caused by depositing lime, concrete, plaster, or other base materials near roots zones.
8. Cutting of roots larger than one inch in diameter.

1.5 DAMAGE ASSESSMENT

- A. When trees other than those designated for removal are destroyed or damaged as result of construction operations, as determined by Engineer, remove and replace with same size, species, and variety up as specified by Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Pruning Paint: Black latex, water based paint, free of all petroleum products.
- B. Fertilizer: Fertilizer shall be a root stimulant that contains at a minimum the following ingredients: Ectomycorrhizal Fungi, VA Mycorrhizal (VAM) Fungi, Rhizosphere Bacillus spp., Kelp Meal Humic Acid, and Soluble Yucca.
- C. Tree Protection Fencing: Orange, plastic mesh fencing, 4 feet in height with 6 feet high "t" bar posts installed 10 feet on centers as per drawings.
- D. Plastic Root/Soil Protection: Clear polyethylene sheeting, minimum 6 mil, thickness.

PART 3 EXECUTION

3.1 PROTECTION AND MAINTENANCE OF EXISTING TREES AND SHRUBS

- A. Except for trees shown on Drawings or determined by Engineer to be removed and relocated, trees within Project area are to remain in place, be assessed by Arborist, protected from damage, and maintained by Contractor.
- B. For trees or shrubs to remain, perform following:

1. Trim trees and shrubs to remain only under supervision of professional tree surgeon or horticulturist.
 - a. Prune trees according to International Society of Arbor culture specifications.
 - b. Trees and shrubs requiring pruning for construction should also be pruned for balance as well as to maintain proper form and branching habit.
 - c. Cut limbs at branch collar. No stubs should remain on trees. Branch cuts should not gouge outer layer of tree structure or trunk.
 - d. Prior to construction, prune all trees to remain of new or recent growth to maintain basic branching from of trees. Base extent of pruning upon proximity of pavement to trunk and size of tree blockouts and requirements of construction adjacent to tree.
 - e. Limit pruning to young branches as much as possible. Take care to maintain older branches that provide basic form of tree. All pruning shall be done in presence of and direction of Resident Project Representative (RPR).
 - f. Paint cuts over $\frac{3}{4}$ inch in diameter with tree paint, covering exposed, living tissue.
2. Use extreme care to prevent excessive damage to root systems.
 - a. Roots in construction areas shall be cut smoothly with a trencher before excavation begins. Do not allow ripping of roots with a backhoe or other equipment.
 - b. Temporarily cover exposed roots with wet burlap to prevent roots from drying out.
 - c. Cover exposed roots with soil as soon as possible.
3. Prevent damage or compaction of root zone (area below drip line) by construction activities.
 - a. Do not allow scarring of trunks or limbs by equipment or other means.
 - b. Do not store construction materials, vehicles, or excavated material under drip line of trees.
 - c. Do not pour liquid materials under drip line.
4. Water and fertilize remaining trees and shrubs to maintain their health during construction period.
 - a. Supplemental watering of landscaping during construction should be done

once every 7 days in cold months and once every 4 days in hotter months.

- b. This watering shall consist of saturating soils at least 6 to 8 inches beneath surface.
- 5. Water areas currently maintained by private sprinkler systems, while systems are temporarily taken out of service, to maintain health of existing landscapes.
- 6. At Contractor's option, with permission of Engineer, shrubs to remain may be temporarily transplanted and returned to original positions under supervision of professional horticulturist.

3.2 PROTECTION

A. Protection of Trees or Shrubs in Open Area:

- 1. Install steel drive-in fence posts in protective circle, approximately 8 feet on center, not closer than 4 feet to trunk of trees or stems of shrubs.
- 2. Drive steel drive-in fence posts into ground for 3 feet minimum, leaving 5 feet minimum above ground.
- 3. Mount fluorescent orange construction fence on steel fence posts.
- 4. For trees or shrubs in paved areas, instead of drive-in fence posts, mount concrete-filled steel pipe 2½ inches in diameter minimum in rubber auto tires filled with concrete (movable posts).

B. Timber Wrap Protection for Trees in Close Proximity of Moving or Mechanical Equipment and Construction Work: When work is required inside staked or posted construction fencing around protected trees, provide timber wrap protection for trees in close proximity of moving or mechanical equipment and work.

- 1. Wrap trunk with layer of burlap.
- 2. Install 2 by 4s or 2 by 6s (5-foot to 6-foot lengths) vertically, spaced 3 inches to 5 inches apart around circumference of tree trunk.
- 3. Tie in place with 12 to 9 gauge steel wire.

3.3 MAINTENANCE OF NEWLY PLANTED TREES AND REPLANTED TREES

- A. Show proof of capacity to water during dry periods.
- B. Guarantee trees planted for this Project shall remain alive and healthy at least until end of 1-year warranty period and additional 1-year period required by Surface Restoration Bond.

1. Within 4 weeks notice from Engineer, replace dead trees or trees that in opinion of Engineer, have become unhealthy, unsightly or have lost their natural shape as result of additional growth, improper pruning, maintenance or weather conditions.
2. When tree must be replaced, guarantee period begins on date of tree replacement, subject to Engineer's inspection, for no less than 1 year.
3. Straighten leaning trees and bear entire cost.
4. Dispose of trees rejected by Resident Project Representative RPR) and bear entire cost.

END OF SECTION

Section 01565

PROTECTION OF MIGRATORY BIRDS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Protection of migratory birds during construction.
- B. Special conditions for bald and golden eagle protection during construction.
- C. Minimum qualifications of Qualified Biologist for migratory bird nest and bald and golden eagle nest surveys.

1.2 DEFINITIONS

- A. MBTA: Migratory Bird Treaty Act.
- B. Taking: Pursuing, hunting, capturing, killing, or possessing adult or juvenile migratory birds or eggs, or attempting to pursue, hunt, capture, kill or possess adult or juvenile migratory birds or eggs.
- C. Breeding Season for Migratory Birds: The period beginning on March 1 and ending on September 15 of each year.
- D. Winter Season for Bald and Golden Eagles: The period beginning on December 1 of each year and ending on March 1 of the following year.
- E. Nesting Season for Raptors: Raptors nest in late winter and early spring. The nesting period is February 1 – July 15.

1.3 MEASUREMENT AND PAYMENT

- A. Payment for migratory bird nest surveys necessary for compliance with this specification section shall be paid on a Lump Sum basis. Includes field work and preparing and submitting report document.
- B. Payment for temporary bird nest protection fencing shall be paid on a per linear foot basis. Includes maintenance of fencing or replacement if damaged or destroyed during breeding season for migratory birds.
- C. Payment for netting shall be paid on a per square yard basis. Square yardage is calculated using the length of netting measured where it is attached to the ground

and the average height of the netting where it is attached to the structure, tree, or other vegetation. Overlaps will not be measured.

- D. Refer to Section 01270 – Measurement and Payment for Unit Price Procedures.

1.4 REFERENCES

- A. 16 USC Chapter 7, Subchapter II: Migratory Bird Treaty Act.
- B. 16 USC Chapter 5, Subchapter II: Protection of Bald and Golden Eagles.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit name and experience of Qualified Biologist, proposed for use on the Work, to Engineer.
- C. Submit signed nest survey report from the Qualified Biologist to the Engineer prior to proceeding with construction activities in areas which have migratory bird nests or bald and goldeneagle nests.

1.6 QUALIFICATIONS

- A. Biologist for Migratory Bird and Bald and Golden Eagle Nest Surveys.
 - 1. Employ a Qualified Biologist to perform and complete all migratory bird and bald and golden eagle nest surveys as may be required. The Qualified Biologist shall be normally engaged in the field and have a minimum of five years of experience in conducting migratory bird nest surveys or bald and golden eagle nest surveys.
 - 2. Qualifications of the selected Qualified Biologist shall be submitted for review and approval by the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Bird Nest Protection Fencing
 - 1. Bird nest protection fencing shall be made of orange plastic mesh, 4 feet in height, and shall be installed with 6-foot high “T” bar posts placed 10 feet on centers. Refer to Section 01562 – Tree and Plant Protection.

B. Netting

1. Netting shall consist of a fabric mesh with openings that are 3/4 inch or less in diameter that can be affixed to structures or trees.

PART 3 EXECUTION

3.1 GENERAL

- A. Areas that will be disturbed or anticipated to be disturbed by construction activities during the breeding season for migratory birds may contain active bird nests and must be surveyed by a Qualified Biologist within five days before beginning work. Nest surveys shall include areas within 150 feet of the designated work limits.
- B. Notify the Engineer at least ten working days in advance of the need for the biologist to perform nest survey.
- C. Migratory birds are protected by the provisions of the MBTA. Report any taking of a migratory bird to the Engineer on the form in Attachment B of this specification section.

3.2 ACTIVE BIRD NESTS AND GROUND CLEARING

- A. During the breed season for migratory birds, areas scheduled for clearing that contain active bird nests must be protected and remain undisturbed until younglings have fledged (i.e., left the nest). The limits of the protected and undisturbed area shall be a radius length of at least 150 feet from active nests, or as recommended by the Qualified Biologist that performed the nest survey.
- B. The Contractor shall install temporary bird nest protection fencing placed at a minimum radius distance of 150 feet from active nests. A larger buffer length shall be used if recommended by the Qualified Biologist.
- C. Active nest protection areas shall remain protected and undisturbed until younglings have fledged, or the nest becomes inactive.
- D. If possible, do not remove vegetation during the breeding season for migratory birds, while active nests are present.
- E. Avoid active migratory bird nests and the area within 150 feet of the nests or within the area recommended by the Qualified Biologist until younglings have fledged.

- F. If during construction, birds establish a nest within the planned areas to be disturbed, the Contractor shall install temporary plastic protection fencing a minimum radius distance of 150 feet from the nest. The area shall remain protected and undisturbed until the younglings have fledged (*i.e.*, left the nest) or the nest becomes inactive.
- G. Contractor shall maintain temporary bird protection fencing throughout the breed season for migratory birds, or until an active nest becomes inactive. If the temporary bird protection fencing becomes damaged, destroyed, removed or not properly installed, the Engineer will suspend work, wholly or in part, until the Contractor repairs the fencing or corrects identified deficiencies.
- H. If an active nest is discovered that was not identified during the bird nest survey, the area around it, within 150 feet, shall be protected with temporary fencing and shall not be further disturbed until the younglings have fledged or the nest becomes inactive.
- I. Remove temporary bird protection fencing and netting at the end of each breeding season, or at completion of construction activities fencing.
- J. If the project continues into successive breeding seasons for migratory birds, the above steps shall be repeated for each successive season.

3.3 WORK ON STRUCTURES

- A. If possible, do not do work on existing structures that have eaves, exposed aerial beams, or other characteristics that can support active bird nests during the breeding season for migratory birds, while active nests are present.
- B. Remove any existing nests before the breeding season for migratory birds begins. If the contract is not awarded before the breeding season for migratory birds begins and the Contractor has removed existing nests, then monitoring of nest building shall become the Contractor's responsibility upon the Notice to Proceed.
- C. All existing structures scheduled for work during the breeding season for migratory birds must first be surveyed for active migratory bird nests by a Qualified Biologist within five days before starting any construction.
- D. Monitor all existing structures for any new nesting activity at least once every three days during the breeding season for migratory birds. If birds start to build any new nests on structures during the breeding season for migratory birds, remove the nests before they become established (*i.e.*, before there are eggs or juvenile birds in the nests). Water shall not be used to remove the nests.
- E. If approved by the Engineer, netting may be installed to prevent nest building. The netting shall be monitored and repaired or replaced as needed. Remove netting upon completion of construction.

- F. If new active nests become established (*i.e.*, there are eggs or juvenile birds in the nests), avoid all work that could result in abandonment or destruction of the nests until the juvenile birds have fledged and the nests are unoccupied, as determined by a Qualified Biologist and approved by the Engineer. The Contractor shall prevent construction activity from displacing birds after they have laid their eggs and before the juveniles have fledged.

3.4 RECORD-KEEPING FOR MIGRATORY BIRDS AND NESTS

- A. A Qualified Biologist shall record, on the form provided in Attachment A of this section, the location of each protected nest, bird species, protection method used, and date installed. Copies of these records shall be provided to the Engineer.
- B. If a bird is killed or injured in the work area, or if an egg is destroyed, record on the form provided in Attachment B of this section the number of adult and juvenile birds killed or injured, the number of destroyed eggs, the location of the nest, the bird species, and the disposition of the killed or injured birds and destroyed eggs. The record shall be submitted to the Engineer for forwarding to the U.S. Fish & Wildlife Service, as appropriate.

PART 4 SPECIAL PROVISIONS FOR BALD OR GOLDEN EAGLES AND RAPTORS

4.1 BALD AND GOLDEN EAGLE ROOSTING ACTIVITY

- A. Before construction begins, a Qualified Biologist shall determine whether bald or golden eagle roosts are present within the work area limits during the winter season for bald and golden eagles.
- B. If eagles are present and construction is scheduled for the winter season for bald and golden eagles (December 1st through March 1st), the Qualified Biologist shall conduct dusk and dawn surveys of bald or golden eagle roosts during the winter season for bald and golden eagles, or within five days before starting any construction, whichever comes later. The Qualified Biologist will prepare and submit a report of findings and recommendations to the Engineer.
- C. If the Qualified Biologist identifies a bald or golden eagle roost, construction activity shall not proceed until the Engineer notifies the U.S. Fish & Wildlife Service and primary and secondary buffer zones are established around active nocturnal roost sites. Construction may only continue if in compliance with U.S. Fish & Wildlife instructions within these buffer zones.

4.2 RAPTOR NESTING ACTIVITY

- A. A Qualified Biologist shall determine before construction begins whether raptor nests are present within the work area limits during the breeding season for migratory birds.
- B. If the Qualified Biologist determines that raptor nests are present and construction is scheduled for the breeding season for migratory birds, the Qualified Biologist shall conduct raptor nest surveys within 1/2 mile of the work limits during the breeding season for migratory birds, or within five days before starting any construction, whichever comes later. The Qualified Biologist will prepare and submit a report of findings and recommendations to the Engineer.
- C. If the Qualified Biologist identifies any active raptor nests within 800 feet of construction activities, the Qualified Biologist shall establish appropriate buffer zones around active nest sites within the 800-foot radius and within work limits. The buffer zones shall be marked with fencing and signs. Work shall not proceed within a buffer zone until a Qualified Biologist has determined that the juvenile birds have fledged and the nest is unoccupied.

END OF SECTION

**ATTACHMENT A TO SECTION 01565
MIGRATORY BIRD AND NEST SURVEY FORM**

Migratory Bird and Nest Survey Form

Project Name: West Harris County Regional Water Authority		Project No. _____
Location: Station	Latitude:	Longitude:
Weather Conditions: Temperature, Cloud Cover, Wind Speed, Wind Direction, Precipitation		
Survey Description: Survey area location, extent, plant cover, extent of development		
1. Location: Activity seen:		
2. Location: Activity seen:		
3. Location: Activity seen:		
4. Location: Activity seen:		
5. Location: Activity seen:		
6. Location: Activity seen:		
Additional Comments:		
Recommendations for Future Surveys:		

Return completed form to the West Harris County Regional Water Authority

**ATTACHMENT B TO SECTION 01565
TAKE OF MIGRATORY BIRDS OR EGGS REPORT FORM**

Take of Migratory Birds or Eggs Report Form

Project Name: West Harris County Regional Water Authority		Project No. _____
Location: Station	Latitude:	Longitude:
Finder's Name and Telephone Number:		Discovery Date and Time:
Nature of Take:		
Adult Birds	Juvenile Birds	Eggs
1. Number Dead: _____ Injured _____ Species:	Number Dead: _____ Injured _____ Species:	Number: _____ Species:
2. Number Dead: _____ Injured _____ Species:	Number Dead: _____ Injured _____ Species:	Number: _____ Species:
3. Number Dead: _____ Injured _____ Species:	Number Dead: _____ Injured _____ Species:	Number: _____ Species:
4. Number Dead: _____ Injured _____ Species:	Number Dead: _____ Injured _____ Species:	Number: _____ Species:
5. Number Dead: _____ Injured _____ Species:	Number Dead: _____ Injured _____ Species:	Number: _____ Species:
Likely causes of mortality or injury:		
Disposition of dead or injured birds and eggs:		
Reporter's Name and Phone Number:		
Date sent to US Fish and Wildlife Service:		

Send completed form promptly to Engineer, who should then forward to the U.S. Fish & Wildlife Service, Clear Lake Field Office, 17629 El Camino Real, Suite 211, Houston, TX 77058

Section 01570

STORM WATER POLLUTION PREVENTION CONTROL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Implementation of Storm Water Pollution Prevention Plans (SWP3) described in Section 01410 – TPDES Requirement.
- B. Installation, maintenance and removal, of storm water pollution prevention structures: diversion dikes, interceptor dikes, diversion swales, interceptor swales, down spout extenders, pipe slope drains, paved flumes and levelspreaders.
Structures are used during construction and prior to final development of the site.
- C. Filter Fabric Barriers:
 - 1. Type 1: Temporary filter fabric barrier for erosion and sediment control in non-channelized flow areas.
 - 2. Type 2: Temporary reinforced filter fabric barrier for erosion and sediment control in channelized flow areas.
- D. Hay Bale Fence.
- E. Drop Inlet Basket
- F. Inlet Sediment Traps
- G. Brush Berm
- H. Sand Bag Barrier
- I. Bagged Gravel Barrier
- J. Sediment Basin
- K. Inlet Protection Barrier

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES

1. Payment for filter fabric barrier is on a linear foot basis measured between limits of beginning and ending of stakes.
2. Payment for reinforced filter fabric barrier is on a linear foot basis measured between limits of beginning and ending of stakes.
3. Payment for drop inlet baskets is on a unit price basis for each drop inlet basket.
4. Payment for storm inlet sediment traps is on a unit price basis for each storm inlet sediment trap.
5. Payment for storm water pollution prevention structures is on a lump sum basis for the project. Earthen structures with outlet and piping include diversion dikes, interceptor dikes, diversion swales, interceptor swales, and excavated earth-outlet sediment trap, embankment earth-outlet sediment trap, down spout extenders, pipe slope drains, paved flumes, stone outlet sediment trap, and levelspreaders.
6. Payment for hay bale barrier, if included in Bid Form, is on a linear foot of accepted bale barriers, if not include in cost of storm water pollution prevention structures.
7. Payment for brush berm, if included in Bid Form, is on a linear foot of accepted brush berm, if not include in cost of storm water pollution prevention structures.
8. Payment for sandbag barrier, if included in Bid Form, is on a linear foot basis measured between limits of beginning and ending of sandbags, if not include in cost of storm water pollution prevention structures.
9. Payment for bagged gravel barrier, if included in Bid Form, is on a linear foot basis measured between limits of beginning and ending of bagged gravel barrier, if not include in cost of storm water pollution prevention controls.
10. Payment for inlet protection barriers, if included in Bid Form, is on a linear foot basis measured along outside face of inlet protection barrier, if not include in cost of storm water pollution prevention structures.
11. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. STIPULATED PRICE (LUMP SUM) CONTRACT.

1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated.

1.3 REFERENCE STANDARDS

A. ASTM

1. A 36 – Standard Specification for Carbon Structural Steel.
2. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600kN-m/m³)).
3. D3786 – Standard Test Method for Hydraulic Bursting Strength for knitted Goods and Nonwoven Fabrics.
4. D 4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
5. D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
6. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
7. D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
8. D 6382 - Standard Practice for Dynamic Mechanical Analysis and Thermogravimetry of Roofing and Waterproofing Membrane Material.

- B. Storm Water Management Handbook for Construction Activities prepared by City of Houston, Harris County and Harris County Flood Control District.

1.4 SYSTEM DESCRIPTIONS

- A. Filter Fabric Barrier Type 1 and Type 2: Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. Maintain Filter Fabric Barriers to remain in proper position and configuration at all times.
- B. Hay Bale Fence: Install to allow surface runoff percolation through hay in sheet-flow manner and to retain and accumulate sediment. Maintain Hay Bale Fence to remain in proper position and configuration at all times.

- C. Interceptor Dikes and Swales: Construct to direct surface or channel runoff around the project area or runoff from project area into sediment traps.
- D. Drop Inlet Baskets: Install to allow runoff percolation through the basket and to retain and accumulate sediment. Clean accumulation of sediment to prevent clogging and backups.
- E. Sediment Traps: Construct to pool surface runoff from construction area to allow sediment to settle onto the bottom of trap.
- F. Sand Bags: Used during construction activities in unstabilized minor swales, ditches, or streambeds when the contributing drainage area is no greater than 2 acres. It is also sediment barrier for stage one Inlet.
- G. Bagged Gravel Barrier: Used during construction activities in unstabilized minor swales, ditches, or streambeds when the contributing drainage area is no greater than 2 acres. It is also sediment barrier for stage two Inlet.
- H. Brush Berm: Constructed along the perimeter of a distribute site within the controlled area.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's literature for product specifications and installation instructions.
- C. Submit manufacturer's catalog sheets and other product data on geotextile or filter fabrics, outlet pipe, perforated riser and connectors.
- D. Submit proposed methods, equipment, materials, and sequence of operations for storm-water pollution prevention structures.
- E. Submit shop drawings for Drop Inlet Baskets.

PART 2 P R O D U C T S

2.1 CONCRETE

- A. Concrete: Class B in accordance with Section 03315 – Concrete for Utility Construction or as shown on the Drawings.

2.2 AGREGATE MATERIALS

- A. Use poorly graded cobbles with diameter greater than 3 inches and less than 5 inches.
- B. Provide gravel lining in accordance with Section 2320 – Utility Backfill Materials or as shown on the drawings.
- C. Provide clean cobbles and gravel consisting of crushed concrete or stone. Use clean, hard crushed concrete or stone free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic matter.
- D. Sediment Pump Pit Aggregate: Use nominal 2-inch diameter river gravel.

2.3 PIPE

- A. Polyethylene culvert pipe or PVC sewer pipe in accordance with Section 02505- High Density Polyethylene (HDPE) Solid and Profile Wall Pipe and Section 02506 Polyvinyl Chloride Pipe or as shown on the Drawings.
- B. Inlet Pipes: Galvanized steel pipe in accordance with Section 02642 Corrugated Metal Pipe or as shown on the Drawings.
- C. Standpipe for Sediment Pump Pits: Galvanized round culvert pipe or round PVC pipe, minimum of 12-inch and a maximum of 24-inch diameter, perforate at 6 to 12 inch centers around circumference.

2.4 GEOTEXTILE FILTER FABRIC

- A. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.
- B. Grab Strength: 100 psi in any principal direction (ASTM D-4632), Mullen burst strength >200 psi (ASTM D-3786), and equivalent opening size between 50 and 140.
- C. Furnish ultraviolet inhibitors and stabilizers for minimum 6 months of expected usable construction life at temperature range of 0 degrees F to 120 degrees F.
- D. Mirafi, Inc., Synthetic Industries, or equivalent

2.5 BARRIER

- A. Wire Barrier: Woven galvanized steel wire, 14 gauge by 6-inch square mesh spacing, minimum 24 inch roll or sheet width of longest practical length.

- B. Barrier Stakes: Nominal 2 by 2 inch moisture-resistant treated wood or steel posts (min. of 1.25 lbs. per linear foot and Brinell Hardness greater than 140) with safety caps on top; length as required for minimum 8 inch bury and full height of filter fabric.

2.6 SANDBAGS

- A. Provide woven material made of polypropylene, polyethylene, or polyamide material.
 - 1. Minimum unit weight of four ounces per square yard.
 - 2. Minimum grab strength of 100 lbs in any principal direction (ASTM D4632)
 - 3. Mullen burst strength exceeding 300 lbs (ASTM D4833).
 - 4. Ultraviolet stability exceeding 70 percent. After 500 hours of exposure (ASTM 4355).
 - 5. Size: Length: 18 to 24 inches. Width: 12 to 18 inches. Thickness: 6 to 8 inches. Weight: Approximately 40 to 50 pounds not to exceed 75 pounds.

2.7 Bagged gravel Barrier

- 1. Minimum unit weight of four ounces per square yard.
- 2. Minimum grab strength of 100 lbs in any principal direction (ASTM D4632)
- 3. Mullen burst strength exceeding 300 lbs (ASTM D4833).
- 4. Ultraviolet stability exceeding 70 percent. After 500 hours of exposure (ASTM 4355).
- 5. Size: Length: 18 to 24 inches. Width: 12 to 18 inches. Thickness: 6 to 8 inches. Weight: Approximately 40 to 50 pounds not to exceed 75 pounds.

2.8 DROP INLET BASKET

- A. Provide steel frame members in accordance with ASTM A36.
- B. Construct top frame of basket with two short sides of 2 inch by 2 inch and single long side of 1 inch by 1 inch, 1/8 inch angle iron. Construct basket hangers of 2 inch by 1/4 inch iron bars. Construct bottom frame of 1 inch by 1/4 inch iron bar or 1/4 inch plate with center 3 inches removed. Use minimum 1/4 inch diameter iron

rods or equivalent for sides of inlet basket. Weld minimum of 14 rods in place between top frame/basket hanger and bottom frame. Exact dimensions for top frame and insert basket will be determined based on dimensions of type of inlet being protected.

2.9 HAY BALE

- A. Hay: Standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Do not use jute or cotton binding.
- B. Hay Bale Stakes (applicable where bales are on soil): No. 3 (3/8 diameter) reinforcing bars, deformed or smooth at Contractor's option, length as required for minimum 18 inch bury and full height bales.

PART 3 EXECUTION

3.1 PREPARATION, INSTALLATION AND MAINTENANCE

- A. Provide erosion and sediment control structures at locations shown on the Drawings.
- B. Do not clear, grub or rough cut until erosion and sediment control systems are in place unless approved by Engineer to allow installation of erosion and sediment control systems, soil testing and surveying.
- C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Engineer to remove and discard existing system.
- D. Regularly inspect and repair or replace damaged components of erosion and sediment control structures. Unless otherwise directed, maintain erosion and sediment control structure until project area stabilization is accepted. . Redress and replace granular fill at outlets as needed to replenish depleted granular fill. Remove erosion and sediment control structures promptly when directed by Engineer. Dispose of materials in accordance with Section 01576 - Waste Material Disposal.
- E. Remove and dispose sediment deposits at the designated spoil site for the Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at approved location in accordance with Section 01576 - Waste Material Disposal.
- F. Unless otherwise shown on the Drawings, compact embankments, excavations, and trenches in accordance with Section 02315 Roadway Excavation or Section 2317 Excavation and Backfill for Utilities.
- G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated right of way and easements for construction. Immediately repair damage caused

by construction traffic to erosion and sediment control structures.

- H. Protect existing trees and plants in accordance with Section 01562 – Tree and Plant Protection.

3.2 SEDIMENT TRAPS

- A. Install sediment traps so that surface runoff shall percolate through system in sheet flow fashion and allow retention and accumulation of sediment.
- B. Inspect sediment traps after each rainfall, daily during periods of prolonged rainfall, and at a minimum once each week. Repair or replace damaged sections immediately.
- C. Use fill material for embankment in accordance with Section 02320 – Utility Backfill Materials.
- D. Excavation length and height shall be as specified on Drawings. Use side slopes of 2:1 or flatter.
- E. Stone outlet sediment traps:
 - 1. Maintain minimum of 6 inches between top of core material and top of stone outlet, minimum of 4 inches between bottom of core material and existing ground and minimum of 1 foot between top of stone outlet and top of embankment.
 - 2. Embed cobbles minimum of 4 inches into existing ground for stone outlet. Core shall be minimum of 1 foot in height and in width and wrapped in triple layer of geotextile filter fabric.
- F. Sediment Basin with Pipe Outlet Construction Methods: Install outlet pipe and riser as shown on the Drawings.
- G. Remove sediment deposits when design basin volume is reduced by one-third or sediment level is one foot below principal spillway crest, whichever is less.

3.3 FILTER FABRIC BARRIER CONSTRUCTION METHODS

- A. Fence Type 1: Filter Fabric: Barrier
 - 1. Install stakes 3 feet on center maximum and firmly embed minimum 8 inches in soil. If filter fabric is factory preassembled with support netting, then maximum support spacing is 8 feet. Install wood stakes at a slight angle toward the source of anticipated runoff.

2. Trench in the toe of the fence lines so the downward face of the trenches is flat and perpendicular to direction of flow. V-trench configuration as shown on Drawings may also be used.
 3. Lay fabric along edges of trenches in longest practical continuous runs to minimize joints. Make joints only at a support post. Splice with minimum 6-inch overlap and seal securely.
 4. Staple filter fabric to stakes at maximum 3 inches on center. Extend fabric minimum 18 inches and maximum 36 inches above natural ground.
 5. Backfill and compact trench.
- B. Barrier Type 2: Reinforced Filter Fabric Barrier
1. Layout barrier same as for Type 1.
 2. Install stakes at 6 feet on center maximum and at each joint in wire fence, firmly embedded 1-foot minimum, and inclined it as for Type 1.
 3. Tie wire fence to stakes with wire at 6 inches on center maximum. Overlap joints minimum one bay of mesh.
 4. Install trench same as for Type 1.
 5. Fasten filter fabric wire fence with tie wires at 3 inches on center maximum.
 6. Layout fabric same as for Type 1. Fasten to wire fence with wire ties at 3 inches on center maximum and, if applicable, to stakes above top of wire fence it as for Type 1.
 7. Backfill and compact trench.
 8. Attach filter fabric to wooden fence stakes spaced a maximum of 6 feet apart or steel fence stakes spaced a maximum of 8 feet apart and embedded a minimum of 12 inches. Install stakes at a slight angle toward source of anticipated runoff.
 9. Trench in toe of filter fabric barrier with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow. A V-trench configuration may also be used. Lay filter fabric along edges of trench. Backfill and compact trench upon completion of Construction.
 10. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.

11. Cut length of fence to minimize use of joints. When joints are necessary, splice fabric together only at support post with minimum 6 inch overlap and seal securely.
12. When used in swales, ditches or diversions, elevation of barrier at top of filter fabric at flowline location in channel shall be lower than bottom elevation of filter fabric at ends of barrier or top of bank, whichever is less, in order to keep storm water discharge in channel from overtopping bank.

C. Triangular Filter Fabric Barrier Construction Methods

1. Attach filter fabric to wire fencing, 18 inches on each side. Provide a fabric cover and skirt with continuous wrapping of fabric. Skirt should form continuous extension of fabric on upstream side of fence.
2. Secure triangular fabric filter barrier in place using one of the following methods:
 - a. Toe-in skirt 6 inches with mechanically compacted material;
 - b. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock; or
 - c. Trench-in entire structure 4 inches.
3. Anchor triangular fabric filter barrier structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt, or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.
4. Lap fabric filter material by 6 inches to cover segment joints. Fasten joints with galvanized shoat rings.

3.4 DIKE AND SWALE

- A. Unless otherwise indicated, maintain minimum dike height of 18 inches, measured from cleared ground at up slope toe to top of dike. Maintain side slopes of 2:1 or flatter.
- B. Dike and Swale Stabilization: When shown on the Drawings, place gravel lining 3 inches thick and compacted into the soil or 6 inches thick if truck crossing is expected. Extend gravel lining across bottom and up both sides of swale minimum height of 8 inches vertically, above bottom. Gravel lining on dike side shall extend up the up slope side of dike a minimum height of 8 inches, measured vertically from interface of existing or graded ground and up slope toe of dike, as shown on Drawings.

- C. Divert flow from dikes and swales to sediment basins, stabilized outlets, or sediment trapping devices of types and at locations shown on Drawings. Grade dikes and swales as shown on Drawings, or, if not specified, provide positive drainage with maximum grade of 1 percent to outlet or basin.
- D. Clear in accordance with Section 02233 – Clearing and Grubbing Compact embankments in accordance with Section 02315 – Roadway Excavation.
- E. Carry out excavation for swale construction so that erosion and water pollution is minimal. Minimum depth shall be 1 foot and bottom width shall be 4 feet, with level swale bottom. Excavation slopes shall be 2:1 or flatter. Clear, grub and strip excavation area of vegetation and root material.

3.5 DOWN SPOUT EXTENDER

- A. Down spout extender shall have slope of approximately 1 percent. Use pipe diameter of 4 inches or as shown on the Drawings. Place pipe in accordance with Section 02317 - Bedding and Backfill for Utilities.

3.6 PIPE SLOPE DRAIN

- A. Compact soil around and under drain entrance section to top of embankment in lifts appropriately sized for method of compaction utilized.
- B. Inlet pipe shall have slope of 1 percent or greater. Use pipe diameter as shown on the Drawings.
- C. Top of embankment over inlet pipe and embankments directing water to pipe shall be at least 1 foot higher at all points than top of inlet pipe.
- D. Pipe shall be secured with hold-down grommets spaced 10 feet on centers.
- E. Place riprap apron with a depth equal to pipe diameter with 2:1 side slopes.

3.7 PAVED FLUME

- A. Compact soil around and under the entrance section to top of the embankment in lifts appropriately sized for method of compaction utilized.
- B. Construct subgrade to required elevations. Remove and replace soft sections and unsuitable material. Compact subgrade thoroughly and shape to a smooth, uniform surface.
- C. Construct permanent paved flumes in accordance with Drawings.

- D. Remove sediment from riprap apron when sediment has accumulated to depth of one foot.

3.8 LEVEL SPREADER

- A. Construct level spreader on undisturbed soil and not on fill. Ensure that spreader lip is level for uniform spreading of storm runoff.
- B. Maintain at required depth, grade, and cross section as specified on Drawings. Remove sediment deposits as well as projections or other irregularities which will impede normal flow.

3.9 INLET PROTECTION BARRIER

- A. Place sandbags for Stage I, Bagged gravel for Stage II and filter fabric barriers at locations shown on the SWP3. Maintain to allow minimal inlet in flow restrictions / blockage during storm event.

3.10 DROP INLET BASKET CONSTRUCTION METHODS

- A. Fit inlet insert basket into inlet without gaps around insert at locations shown on the SWP3.
- B. Support for inlet insert basket shall consist of fabricated metal as shown on Drawings.
- C. Push down and form filter fabric to shape of basket. Use sheet of fabric large enough to be supported by basket frame when holding sediment and extend at least 6 inches past frame. Place inlet grates over basket/frame to serve as fabric anchor.
- D. Remove sediment deposit after each storm event and whenever accumulation exceeds 1-inch depth during weekly inspections.

3.11 HAY BALE FENCE CONSTRUCTION METHODS

- A. Place bales in row with ends tightly abutting adjacent bales. Place bales with bindings parallel to ground surface.
- B. Embed bale in soil a minimum of 4 inches.
- C. Securely anchor bales in place with Hay Bale Stakes driven through bales a minimum of 18-inches into ground. Angle first stake in each bale toward previously laid bale to force bales together.
- D. Fill gaps between bales with straw to prevent water from channeling between bales.

Wedge carefully in order not to separate bales.

- E. Replace with new hay bale fence every two months or as required by Engineer.

3.12 BRUSH BERM CONSTRUCTION METHODS

- A. Construct brush berm along contour lines by hand placing method. Do not use machine placement of brush berm.
- B. Use woody brush and branches having diameter less than 2-inches with 6- inches overlap. Avoid incorporation of annual weeds and soil into brush berm.
- C. Use minimum height of 18-inches measured from top of existing ground at upslope toe to top of berm. Top width shall be 24 inches minimum and side slopes shall be 2:1 or flatter.
- D. Embed brush berm into soil a minimum of 4-inches and anchor using wire, nylon or polypropylene rope across berm with a minimum tension of 50 pounds. Tie rope securely to 18-inch x 3/8-inch diameter rebar stakes driven into ground on 4-foot centers on both sides of berm.

3.13 STREET AND SIDEWALK CLEANING

- A. Keep areas clean of construction debris and mud carried by construction vehicles and equipment. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas, following Section 01575- Stabilized Construction Exit.
- B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not water hose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

3.14 WASTE COLLECTION AREAS

- A. Prevent water runoff from passing through waste collection areas, and prevent water runoff from waste collection areas migrating outside collection areas.

3.15 EQUIPMENT MAINTENANCE AND REPAIR

- A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.
- B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants

from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

3.16 VEHICLE/ EQUIPMENT WASHING AREAS

- A. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction access, as required to prevent mud and dirt run-off. Release wash water into drainage swales or inlets protected by erosion and sediment controls. Build wash areas following Section 01575- Stabilized Construction access. Install gravel or rock base beneath wash areas.
- B. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into waterways or storm water conveyance systems.
- C. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground, or collect runoff in temporary holding or seepage basins.

3.17 WATER RUNOFF AND EROSION CONTROL

- A. Control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties. Follow environment requirements.
- B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.
- C. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- D. Retain existing drainage patterns external to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover as required to control conditions.
- E. Plan and execute construction and earth work to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
 - 1. Hold area of bare soil exposed at one time to a minimum.
 - 2. Provide temporary controls such as berms, dikes, and drains.
- F. Construct fill and waste areas by selective placement to eliminate surface silts or clays which will erode.

- G. Inspect earthwork periodically to detect start of erosion. Immediately apply corrective measures as required to control erosion.
- H. Dispose of sediments offsite, not in or adjacent to waterways or floodplains, nor allow sediments to flush into streams or drainage ways. Assume responsibility for offsite disposal location.
- I. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8- inch layers. Provide compaction density at minimum 90 percent Standard Proctor ASTM D-698-78 density. Make at least one test per 500 cubic yards of embankment.
- J. Prohibit equipment and vehicles from maneuver on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sedimentation control systems caused by construction traffic.
- K. Do not damage existing trees intended to remain.

3.18 REMOVAL OF CONTROLS

- A. Remove erosion and sediment controls when the site is finally stabilized or as directed by Engineer.
- B. Dispose of sediments and waste products following Section 01504 -Temporary Facilities and Controls.

END OF SECTION

Section 01575

STABILIZED CONSTRUCTION ACCESS

PART1 G E N E R A L

1.1 SECTION INCLUDES

- A. Installation and removal of erosion and sediment control for stabilized construction access used during construction and prior to final development of site.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price Contracts. If Contract is Unit Price Contract, payment for work in this Section will be based on the following:
 - 1. Stabilized construction roads, parking areas, access and wash areas: per each location of aggregate/recycled concrete without reinforcing placed in 8-inch layers. No separate payment will be made for street cleaning necessary to meet TPDES requirements. Include cost of work for street cleaning under related Specification section.
- B. Stipulated Price (Lump Sum) Contracts. If the Contract is a Stipulated Price Contract, include payment for work under this Section in the total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's catalog sheets and other Product Data on geotextile fabric.
- C. Submit sieve analysis of aggregates conforming to requirements of this Specification.

1.4 REFERENCES

- A. ASTM D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- B. Storm Water Quality Management Handbook For Construction Activities prepared by the City of Houston, Harris County and Harris County Flood Control District.

PART 2 P R O D U C T S

2.1 GEOTEXTILE FABRIC

- A. Provide woven or non-woven geotextile fabric made of polypropylene, polyethylene, ethylene, or polyamide material.
- B. Geotextile fabric: Minimum grab strength of 200 lbs in any principal direction (ASTM D-4632) and equivalent opening size between 50 and 140.
- C. Geotextile and threads: Resistant to chemical attack, mildew, and rot and contain ultraviolet ray inhibitors and stabilizers to provide minimum of six months of expected usable life at temperature range of 0 to 120 degrees F.
- D. Representative Manufacturers: Mirafi, Inc. or equal.

2.2 COARSE AGGREGATES

- A. Coarse aggregate: Crushed stone, gravel, crushed blast furnace slag, or combination of these materials. Aggregate shall be composed of clean, hard, durable materials free from adherent coatings of, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.
- B. Coarse aggregates to consist of open graded rock 2" to 8" in size.

PART 3 EXECUTION

3.1 PREPARATION AND INSTALLATION

- A. Provide stabilized construction roads and access at construction, staging, parking, storage, and disposal areas to keep street clean of mud carried by construction vehicles and equipment. Construct erosion and sediment controls in accordance with Drawings and Specification requirements.
- B. Do not clear grub or rough cut until erosion and sediment control systems are in place, unless approved by Engineer to allow soil testing and surveying.
- C. Maintain existing construction site erosion and sediment control systems until acceptance of the Work or until removal of existing systems is approved by Engineer.
- D. Regularly inspect, repair or replace components of stabilized construction access. Unless otherwise directed, maintain stabilized construction roads and access until the Engineer accepts the Work. Remove stabilized construction roads and access promptly when directed by Engineer. Discard removed materials off-site. Remove and dispose of sediment deposits at designated spoil site for Project. If a spoil site is not designated on

Drawings, dispose of sediment off-site at a location not in or adjacent to stream or flood plain. Assume responsibility for off-site disposal.

- E. Spread compacted and stabilized sediment evenly throughout site. Do not allow sediment to flush into streams or drainage ways. Dispose of contaminated sediment in accordance with existing federal, state, and local rules and regulations.
- F. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sediment control systems caused by construction traffic.
- G. Conduct construction operations in conformance with erosion control requirements of Specification 01570 – Storm Water Pollution Control.

3.2 CONSTRUCTION MAINTENANCE

- A. Provide stabilized access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes where shown on Drawings.
- B. Provide stabilized construction access and vehicle washing areas, when approved by Engineer, of sizes and at locations shown on Drawings or as specified in this Section.
- C. Clean tires to remove sediment on vehicles leaving construction areas prior to entering public right-of-ways. Construct wash areas needed to remove sediment. Release wash water into drainage swales or inlets protected by erosion and sediment control measures.
- D. Details for stabilized construction access are shown on Drawings. Construct other stabilized areas to same requirements. Maintain minimum roadway widths of 14 feet for one-way traffic and 20 feet for two-way traffic and of sufficient width to allow ingress and egress. Place geotextile fabric as a permeable separator to prevent mixing of coarse aggregate with underlying soil. Limit exposure of geotextile fabric to elements between laydown and cover to a maximum 14 days to minimize potential damage.
- E. Grade roads and parking areas to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar materials to prevent sediment from entering public right-of-ways, waterways or storm water conveyance systems.
- F. Inspect and maintain stabilized areas daily. Provide periodic top dressing with additional coarse aggregates to maintain required depth. Repair and clean out damaged control systems used to trap sediment. Immediately remove spilled, dropped, washed, or tracked sediment from public right-of- ways.
- G. Maintain lengths of stabilized areas as shown on Drawings or a minimum of 50 feet. Maintain a minimum thickness of 8 inches. Maintain minimum widths at all points of ingress or egress.

- H. Stabilize other areas with the same thickness, and width of coarse aggregate required for stabilized construction access, except where shown otherwise on Drawings.
- I. Stabilized areas may be widened or lengthened to accommodate truck washing areas when authorized by Engineer.
- J. Clean street daily before end of workday. When excess sediments have tracked onto streets, Engineer may direct Contractor to clean street as often as necessary. Remove and legally dispose of sediments.
- K. Use other erosion and sediment control measures to prevent sediment runoff during rain periods and non-working hours and when storm discharges are expected.

END OF SECTION

Section 01576

WASTE MATERIAL DISPOSAL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Disposal of waste material and salvageable material.

1.2 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Obtain and submit disposal permits for proposed disposal sites, if required by local ordinances.
- C. Submit copy of written permission from property owner, with description of property, prior to disposal of excess material adjacent to Project. Submit written and signed release from property owner upon completion of disposal work.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.1 SALVAGEABLE MATERIAL

- A. Excavated Material: When indicated on Drawings, load, haul, and deposit excavated material at location or locations shown on Drawings outside limits of Project.
- B. Other Salvageable Materials: Conform to requirements of individual Specification Sections.
- C. Coordinate loading of salvageable material on Contractor provided trucks with Engineer.

3.2 EXCESS MATERIAL

- A. Remove and legally dispose of vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage from job site.
- B. Excess soil may be deposited on private property adjacent to Project when written

permission is obtained from property owner.

- C. Verify flood plain status of any proposed disposal site. Do not dispose of excavated materials in area designated as within 100-year Flood Hazard Area unless "Development Permit" has been obtained. Remove excess material placed in "100-year Flood Hazard Area", at no additional cost to the Authority.
- D. Remove waste materials from site daily, in order to maintain site in neat and orderly condition.

END OF SECTION

Section 01578

CONTROL OF GROUND AND SURFACE WATER

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Dewatering, depressurizing, draining, and maintaining trenches, shaft excavations, structural excavations and foundation beds in stable condition, and controlling ground water conditions for tunnel excavations.
- B. Protecting work against surface runoff and rising floodwaters.
- C. Trapping suspended sediment in the discharge from the surface and ground water control systems.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. When noted, dewatering of trench or excavation during course of project shall be measured per linear foot and paid for at contract unit prices for dewatering, when directed to perform such work by Engineer. Dewatering must be fully detailed in submittal and submittal must be approved prior to performing dewatering work before payment will be made for dewatering. No payment will be made for work unless directed to perform work by Engineer.
- 2. Presence of a pump on project does not constitute dewatering for payment under bid item "Ground Water Control for Open Cut Construction."
- 3. Dewatering required during course of project to lower water table for other utility installation less than 24 inches in diameter, construction of structures, removal of standing water, surface drainage seepage, or to protect against rising waters or floods shall be considered incidental to Work unless otherwise noted.
- 4. No separate payment will be made for groundwater control associated with augering, tunneling or other method of trenchless casing installation. Include cost in unit price for auger or tunnel.
- 5. No separate payment will be made for control of surface water. Include cost to control surface water in unit price for work requiring controls.
- 6. Refer to Section 01270 – Measurement and Payment for unit price procedures.

- B. STIPULATED PRICE (LUMP SUM) CONTRACT: If the Contract is a Stipulated Price Contract, include payment for work under this section in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soils Using Standard Effort (12,400 ft-lbf/ft³(600kN-m/m³)
- B. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).
- C. Storm Water Management Handbook for Construction Activities prepared by City of Houston, Harris County and Harris County Flood Control District.

1.4 DEFINITIONS

- A. Ground water control system: system used to dewater and depressurize water-bearing soil layers.
 - 1. Dewatering: lowering the water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts; and disposing of removed water. Intent of dewatering is to increase stability of tunnel excavations and excavated slopes, prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of excavations, and to provide suitable conditions for placement of backfill materials and construction of structures and other installations.
 - 2. Depressurization: includes reduction in piezometric pressure within strata not controlled by dewatering alone, necessary to prevent failure or heaving of excavation bottom or instability of tunnel excavations.
- B. Excavation drainage: includes keeping excavations free of surface and seepage water.
- C. Surface drainage: includes use of temporary drainage ditches and dikes and installation of temporary culverts and sump pumps with discharge lines necessary to protect Work from any source of surface water.
- D. Monitoring facilities for ground water control system: includes piezometers, monitoring wells and flow meters for observing and recording flow rates.

1.5 PERFORMANCE REQUIREMENTS

- A. Conduct subsurface investigations to identify groundwater conditions and to provide parameters for design, installation, and operation of groundwater control systems. Submit

proposed method and spacing of readings for review prior to obtaining water level readings.

- B. Design ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926 and Section 02260 - Trench Safety Systems, to produce following results:
 - 1. Effectively reduce hydrostatic pressure affecting:
 - a. Excavations
 - b. Tunnel excavation, face stability or seepage into tunnels
 - 2. Develop substantially dry and stable subgrade for subsequent construction operations
 - 3. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities and other work
 - 4. Prevent loss of fines, seepage, boils, quick condition, or softening of foundation strata
 - 5. Maintain stability of sides and bottom of excavations
- C. Provide ground water control systems that include single-stage or multiple- stage well point systems, eductor and ejector-type systems, deep wells, or combinations of these equipment types.
- D. Provide drainage of seepage water and surface water, as well as water from other sources entering excavation. Excavation drainage may include placement of drainage materials, crushed stone and filter fabric, together with sump pumping.
- E. Provide ditches, berms, pumps and other methods necessary to divert and drain surface water from excavation and other work areas.
- F. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.
- G. Assume sole responsibility for ground water control systems and for any loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by ground water control operations. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, adjacent water wells, or potentially contaminated areas. Repair damage caused by ground water control systems or resulting from failure of system to protect property as required.
- H. Install an adequate number of piezometers installed at proper locations and depths, necessary to provide meaningful observations of conditions affecting excavation, adjacent structures and water wells.

- I. Install environmental monitoring wells at proper locations and depths necessary to provide adequate observations of hydrostatic conditions and possible contaminant transport from contamination sources into work area or ground water control system.
- J. Control flow rate of discharged water to prevent overflow of drainage facilities.

1.6 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit Ground Water and Surface Water Control Plan for review by Engineer prior to start of excavation work. Include the following:
 - 1. Results of subsurface investigations and description of extent and characteristics of water bearing layers subject to ground water control.
 - 2. Names of equipment Suppliers and installation Subcontractors.
 - 3. Description of proposed ground water control systems indicating arrangement, location, depth and capacities of system components, installation details and criteria and operation and maintenance procedures.
 - 4. Description of proposed monitoring facilities indicating depths and locations of piezometers and monitoring wells, monitoring installation details and criteria, type of equipment and instrumentation with pertinent data and characteristics.
 - 5. Description of proposed filters including types, sizes, capacities and manufacturer's application recommendations.
 - 6. Design calculations demonstrating adequacy of proposed systems for intended applications. Define potential area of influence of ground water control operation near contaminated areas.
 - 7. Operating requirements, including piezometric control elevations for dewatering and depressurization.
 - 8. Excavation drainage methods including typical drainage layers, sump pump application and other means.
 - 9. Surface water control and drainage installations.
 - 10. Proposed methods and locations for disposing of removed water.
- C. Submit following records upon completion of initial installation:

1. Installation and development reports for well points, eductors, and deep wells
 2. Installation reports and baseline readings for piezometers and monitoring wells
 3. Baseline analytical test data of water from monitoring wells
 4. Initial flow rates
- D. Submit the following records weekly during control of ground and surface water operations:
1. Records of flow rates and piezometric elevations obtained during monitoring of dewatering and depressurization. Refer to Paragraph 3.2, Requirements for Eductor, Well Points, or Deep Wells.
 2. Maintenance records for ground water control installations, piezometers and monitoring wells

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Comply with requirements of agencies having jurisdiction.
- B. Comply with Texas Commission on Environmental Quality regulations and Texas Water Well Drillers Association for development, drilling, and abandonment of wells used in dewatering system.
- C. Obtain necessary permits from agencies with jurisdiction over use of groundwater and matters affecting well installation, water discharge, and use of existing storm drains and natural water sources. Since review and permitting process may be lengthy, take early action to obtain required approvals.
- D. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites.
- E. Provide erosion control measures when discharging water to unlined or vegetation lined channels.

PART 2 P R O D U C T S

2.1 EQUIPMENT AND MATERIALS

- A. Select equipment and materials necessary to achieve desired results for dewatering. Selected equipment and materials are subject to review by Engineer through submittals required in Paragraph 1.6, Submittals.
- B. Use experienced contractors, regularly engaged in ground water control system design,

installation, and operation, to furnish and install and operate educators, well points, or deep wells, when needed

- C. Maintain equipment in good repair and operating condition.
- D. Keep sufficient standby equipment and materials available to ensure continuous operation, where required.
- E. Portable Sediment Tank System: Standard 55-gallon steel or plastic drums, free of hazardous material contamination.
 - 1. Shop or field fabricate tanks in series with main inlet pipe, inter-tank pipes and discharge pipes, using quantities sufficient to collect sediments from discharge water.

PART 3 EXECUTION

3.1 GROUND WATER CONTROL

- A. Perform necessary subsurface investigation to identify water bearing layers, piezometric pressures and soil parameters for design and installation of ground water control systems. Perform pump tests, if necessary to determine draw down characteristics. Present results in the Ground Water and Surface Water Control Plan submittal.
- B. Provide labor, material, equipment, techniques and methods to lower, control and handle ground water in manner compatible with construction methods and site conditions. Monitor effectiveness of installed system and its effect on adjacent property.
- C. Install, operate, and maintain ground water control systems in accordance with the Ground Water and Surface Water Control Plan. Notify Engineer in writing of changes made to accommodate field conditions and changes to Work. Provide revised drawings and calculations with notification.
- D. Provide continuous system operation, including nights, weekends, and holidays. Arrange appropriate backup if electrical power is primary energy source for dewatering system.
- E. Monitor operations to verify systems lower ground water piezometric levels at rate required to maintain dry excavation resulting in stable subgrade for subsequent construction operations.
- F. Depressurize zones where hydrostatic pressures in confined water bearing layers exist below excavations to eliminate risk of uplift or other instability of excavation or installed works. Define allowable piezometric elevations in the Ground Water and Surface Water Control Plan.

G. Removal of ground water control installations.

1. Remove pumping system components and piping when ground water control is no longer required.
2. Remove piezometers, including piezometers installed during design phase investigations and left for Contractor's use, upon completion of testing.
3. Remove monitoring wells when directed by Engineer.
4. Grout abandoned well and piezometer holes. Fill piping that is not removed with cement-bentonite grout or cement-sand grout.

H. During backfilling, maintain water level a minimum of 5 feet below prevailing level of backfill. Do not allow the water level to cause uplift pressures in excess of 80 percent of downward pressure produced by weight of structure or backfill in place. Do not allow water levels to rise into cement-stabilized sand until at least 48 hour after placement.

I. Provide uniform pipe diameter for each pipe drain run constructed for dewatering. Remove pipe drains when no longer required. If pipe removal is impractical, grout connections at 50-foot intervals and fill pipe with cement- bentonite grout or cement-sand grout after removal from service.

J. The extent of ground water control for structures with permanent perforated underground drainage systems may be reduced, for units designed to withstand hydrostatic uplift pressure. Provide a means to drain affected portions of underground systems, including standby equipment. Maintain drainage systems during construction operations.

K. Remove systems upon completion of construction or when dewatering and control of surface or ground water is no longer required.

L. Compact backfill to not less than 95 percent of maximum dry density in accordance with ASTM D 698.

M. Foundation Slab: Maintain saturation line at least 3 feet below lowest elevations where concrete is to be placed. Drain foundations in areas where concrete is to be placed before placing reinforcing steel. Keep free from water for 3 days after concrete is placed.

3.2 REQUIREMENTS FOR EDUCTOR, WELL POINTS, OR DEEP WELLS

A. For aboveground piping in ground water control system, include a 12-inch minimum length of clear, transparent piping between each eductor well or well point and discharge header to allow visual monitoring of discharge from each installation.

B. Install sufficient piezometers or monitoring wells to show that trench or shaft excavations in water bearing materials are pre-drained prior to excavation. Provide separate piezometers for

monitoring of dewatering and for monitoring of depressurization. Install piezometers and monitoring wells for tunneling as appropriate for selected method of work.

- C. Install piezometers or monitoring wells at least one week in advance of the start of associated excavation.
- D. Dewatering may be omitted for portions of under drains or other excavations, where auger borings and piezometers or monitoring wells show that soil is pre-drained by existing systems and that ground water control plan criteria are satisfied.
- E. Replace installations that produce noticeable amounts of sediments after development.
- F. Provide additional ground water control installations, or change method of control if, ground water control plan does not provide satisfactory results based on performance criteria defined by plan and by specifications. Submit revised plan according to Paragraph 1.6.B.

3.3 SEDIMENT TRAPS

- A. Install sediment tanks as needed to prevent discharge of sediment into storm sewers and drainage ditches.
- B. Inspect daily and clean out tank when one-third of sediment tank is filled with sediment.

3.4 SEDIMENT SUMPPIT

- A. Install sediment sump pits as needed to prevent discharge of sediment into storm sewers and drainage ditches.
- B. Construct standpipe by perforating 12 inch to 24-inch diameter corrugated metal or PVC pipe.
- C. Extend standpipe 12 inches to 18 inches above lip of pit.
- D. Convey discharge of water pumped from standpipe to sediment trapping device.
- E. Fill sites of sump pits, compact to density of surrounding soil and stabilize surface when construction is complete.

3.5 EXCAVATION DRAINAGE

- A. Use excavation drainage methods if well-drained conditions can be achieved. Excavation drainage may consist of layers of crushed stone and filter fabric, and sump pumping, in combination with sufficient ground water control wells to maintain stable excavation and backfill conditions.

3.6 MAINTENANCE AND OBSERVATION

- A. Conduct daily maintenance and observation of piezometers or monitoring wells while ground water control installations or excavation drainage is operating at the site, or water is seeping into tunnels, and maintain systems in good operating condition.
- B. Replace damaged and destroyed piezometers or monitoring wells with new piezometers or wells as necessary to meet observation schedules.
- C. Cut off piezometers or monitoring wells in excavation areas where piping is exposed, only as necessary to perform observation as excavation proceeds. Continue to maintain and make specified observations
- D. Remove and grout piezometers inside or outside of excavation area when ground water control operations are complete. Remove and grout monitoring wells when directed by Engineer.

3.7 MONITORING AND RECORDING

- A. Monitor and record average flow rate of operation for each deep well, or for each wellpoint or educator header used in dewatering system. Also, monitor and record water level and ground water recovery. Record observations daily until steady conditions are achieved and twice weekly thereafter.
- B. Observe and record elevation of water level daily as long as ground water control system is in operation, and weekly thereafter until Work is completed or piezometers or wells are removed, except when Engineer determines more frequent monitoring and recording are required. Comply with Engineer's direction for increased monitoring and recording and take measures necessary to ensure effective dewatering for intended purpose.

3.8 SURFACE WATER CONTROL

- A. Intercept surface water and divert it away from excavations through use of dikes, ditches, curb walls, pipes, sumps or other approved means. Requirement includes temporary works required to protect adjoining properties from surface drainage caused by construction operations.
- B. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction. Provide settling basins when required by agencies.

END OF SECTION

Section 01580

PROJECT IDENTIFICATION SIGNS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Project identification sign description.
- B. Project sign installation.
- C. Maintenance and removal of Project sign.

1.2 SYSTEM DESCRIPTION

- A. Sign Construction: Construct signs of new materials in accordance with Standard Detail provided at the Pre-construction Conference.
- B. Appearance: Maintain signs to present a clean and neat look throughout contract duration.
- C. Sign Manufacturer: Experienced professional sign company.
- D. Sign Placement: At locations shown on Drawings unless otherwise specified by Project Manager at pre-construction meeting.
 - 1. Provide one sign at each end of a linear Project involving paving, overlay, sewer line, storm drainage, or water main construction located in rights-of-ways or easements
 - 2. Provide one sign for site or building construction Contracts
 - 3. Provide one sign at each site for Contracts with multiple sites.
 - 4. Sign Relocation: As work progresses, relocate signs if directed by Project Manager in writing.
 - 5. Provide quantity noted on Drawings.
- E. Skid-mounted signs: Use for projects with noncontiguous locations where work progresses from one location to another. Design skid structure to withstand a 60 mile-per-hour wind load to the face or back of sign using stakes, straps, or ballast. Contractor shall be responsible for security of signs at each site.

1.3 SUBMITTALS

- A. Submit Shop Drawings under provisions of Section 01330 - Submittal procedures.
- B. Show content, layout, lettering style, lettering size, and colors. Make sign and lettering to scale, clearly indicating condensed lettering, if used.

PART 2 PRODUCTS

2.1 SIGN MATERIALS

- A. Structure and Framing: Use new sign materials.
 - 1. Sign Posts: 4-inch by 4-inch pressure treated wood posts, 9 feet long for skid mounting and 12 feet long minimum for in-ground mounting.
 - 2. Skid Bracing: 2-inch by 4-inch wood framing material.
 - 3. Skid Members: 2-inch by 6-inch wood framing material.
 - 4. Fasteners:
 - a. Galvanized steel.
 - b. Attach sign to posts with 1/2-inch by 5-1/2 inch button head carriage bolts and secure with nuts and flat head washers.
 - c. Cover button heads with white reflective film or paint to match sign background.
 - d. Use metal brackets and braces and 3/4-inch wood screws to attach sign header.
- B. Sign and Sign Header: 3/4-inch thick marine plywood. Use 4-foot by 8 -foot sheet for the sign and a single piece for the header to minimize joints. Do not piece wood sheets to fabricate sign face.
- C. Paint and Primers: White industrial grade, fast-drying, oil-based paint with gloss finish for structural and framing members, sign, and sign header material surfaces. Paint all sign surfaces prior to adding adhesive applications.
- D. Colors:

1. Sign Background: Reflective white 3M Scotchlite Engineer Grade, Pressure Sensitive Sheeting (White), or approved equal.
2. Border: For red border around area, which designates project name and project amount, use reflective red 3M Scotchlite Engineer Grade, Pressure Sensitive Sheeting (Red), or approved equal.
3. Sign Film: 3M Scotchcal Pressure Sensitive Films, or approved equal for legends, symbols, lettering, and artwork. Match colors to 3M Scotchcal Pressure Sensitive Films.
 - a. Lettering Below Logo(s): Black
 - b. Lettering Above Project Name: Vivid Blue
 - c. Lettering on Blue Background: White
 - d. Background Behind Project Name: Vivid Blue

2.2 SIGN LAYOUT

A. Lettering:

1. Style, Size, and Spacing: Helvetica Regular lettering.
2. Condensed Style: Text may be condensed if needed to maintain sign composition.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install Project identification signs within seven days after Date of Commencement of the Work.
- B. Erect signs at locations shown in Drawings unless otherwise designated by Project Manager at pre-construction meeting. Position sign so it is fully visible and readable to general public.
- C. Erect sign level and plumb.
- D. If mounted on posts, sink posts 3 to 4 feet below grade and stabilize posts to minimize lateral motion. Leave a minimum of 8 feet of post above existing grade for

mounting of sign.

- E. Erect sign so that top edge of sign is at a nominal 8 feet above existing grade.

3.2 MAINTENANCE AND REMOVAL

- A. Keep signs and supports clean. Repair deterioration and damage.
- B. Remove signs, framing, supports, and foundations to a depth of at least 2 feet upon completion of Project. Restore area to a condition equal to or better than before construction.

END OF SECTION

Section 01581

EXCAVATION IN PUBLIC WAY PERMIT SIGNS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Project sign installation.
- B. Maintenance and removal of Project sign.

1.2 SYSTEM DESCRIPTION

- A. Sign Construction: Construct signs of new materials.
- B. Appearance: Maintain signs to present a clean and neat look throughout the Contract duration or phase of construction.
- C. Sign Placement: Place signs at each street entrance to street cut excavation.

1.3 SUBMITTALS

- A. Submit Shop Drawings under provisions of Section 01330 Submittal Procedures.
- B. Show content, layout, lettering style, lettering size and colors. Make sign and lettering to scale, clearly indicating condensed lettering, if used.

PART 2 P R O D U C T S

2.1 SIGN LAYOUT

- A. Conform to Texas Manual on Uniform Traffic Control Devices. Minimum size: 36 inches by 36 inches.
- B. Lettering: Uppercase Helvetica Regular lettering.
- C. Composition: Include on sign copy of street cut permit, title "West Harris County Regional Water Authority", address, and emergency telephone number and Contractor's name. Engineer will provide address, and emergency telephone number for preparation of sign.

PART 3 E X E C U T I O N

3.1 INSTALLATION

- A. Install Project signs a minimum of 72 hours before commencement of pavement excavation in Public Way.
- B. Position sign so it is fully visible and readable to general public.
- C. Erect sign level and plumb.
- D. Erect sign so that top edge of sign is at a nominal 8 feet above existing grade.

3.2 MAINTENANCE AND REMOVAL

- A. Keep signs and supports clean. Repair deterioration and damage.
- B. Remove signs, framing, supports and foundations to depth of at least 2 feet upon completion of the Work. Restore area to condition equal to or better than before construction.

END OF SECTION

Section 01610

BASIC PRODUCT REQUIREMENTS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Requirements for transportation, delivery, handling, and storage of Products.

1.2 PRODUCTS

- A. Products: Includes pre-fabricated or manufactured items designated for installation by the Construction Documents. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. For material and equipment specifically indicated or specified to be reused in the work:
 - 1. Use special care in removal, handling, storage and reinstallation, to assure proper function in completed work.
 - 2. Arrange for transportation, storage and handling of products which require off-site storage, restoration or renovation. Include cost in unit price for related items.
- C. When contract documents require that installation of work comply with manufacturer's printed Instructions, obtain and distribute copies of such instructions to parties involved in installation, including two copies to Engineer. Maintain one set of complete instructions at job site during installation until completion.
- D. Provide Products from the fewest number of manufacturers as practical, in order to simplify spare parts inventory and to allow for maximum interchangeability of components. For multiple components of the same size, type or application, use the same make and model of component throughout the Work.

1.3 TRANSPORTATION

- A. Make arrangements for transportation, delivery, and handling of Products required for timely completion of the Work.
- B. Transport and handle Products in accordance with manufacturer's instructions.
- C. Consign and address shipping documents to proper party giving name of the Project and its complete street address. Shipments shall be delivered to Contractor.

1.4 DELIVERY

- A. Arrange deliveries of Products to accommodate short-term site completion schedules and in ample time to facilitate inspection prior to Installation. Avoid deliveries that cause lengthy storage or overburden of limit storagespace.
- B. Coordinate deliveries to avoid conflict with the Work and conditions at the site and to accommodate the following:
 - 1. Work of other contractors or the Authority.
 - 2. Limitations of storage space.
 - 3. Availability of equipment and personnel for handling Products.
 - 4. The Authority's use of premises.
- C. Have Products delivered to the site in manufacturer's original, unopened, labeled containers.
- D. Immediately upon delivery, inspect shipment to assure:
 - 1. Product complies with requirements of the Contract.
 - 2. Quantities are correct.
 - 3. Containers and packages are intact; labels are legible.
 - 4. Products are properly protected and undamaged.

1.5 PRODUCT HANDLING

- A. Coordinate off-loading of Products delivered to the site. If necessary during construction, move and relocate stored Products at no additional cost to the Authority.
- B. Provide equipment and personnel necessary to handle Products, including those provided by the Authority, by methods to prevent damage to Products or packaging.
- C. Provide additional protection during handling as necessary to prevent breaking, scraping, marring, or otherwise damaging Products or surrounding areas.
- D. Handle Products by methods to prevent over-bending or overstressing.
- E. Lift heavy components only at designated lifting points.
- F. Handle Products in accordance with manufacturer's recommendations.

- G. Do not drop, roll, or skid Products off delivery vehicles. Hand-carry or use Suitable materials handling equipment.

1.6 STORAGE OF PRODUCTS

- A. Store and protect Products in accordance with manufacturer's recommendations and requirements of these Specifications.
- B. Make necessary provisions for safe storage of Products. Place Products so as to prevent damage to any part of the Work or existing facilities and to maintain free access at all times to all parts of the Work and to utility service company installations in the vicinity of the Work. Keep Products neatly and compactly stored in locations that will cause minimum inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants. Arrange storage in a manner so as to provide easy access for inspection.
- C. Restrict storage to areas available on the site for storage of Products as shown on Drawings or approved by Engineer.
- D. Provide off-site storage and protection when on-site storage is not adequate. Provide addresses of, and access to, off-site storage locations for inspection by Engineer.
- E. Do not use lawns, grass plots, or other private property for storage purposes without written permission of owner or other person in possession or control of premises.
- F. Protect stored Products against loss or damage.
- G. Store in manufacturers' unopened containers.
- H. Neatly, safely, and compactly stack Products delivered and stored along the line of the Work to avoid inconvenience and damage to property owners and general public, and maintain at least 3 feet clearance around fire hydrants. Keep public, private driveways and street crossings open.
- I. Repair or replace damaged lawns, sidewalks, streets or other improvements to satisfaction of Engineer. Total length that Products may be distributed along route of construction at one time is 1000 linear feet, unless otherwise approved in writing by Engineer.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

Section 01630

PRODUCT SUBSTITUTION PROCEDURES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Options for making Product or process selections.
- B. Procedures for proposing equivalent Products or processes, including pre-approved, pre-qualified, and approved Products or processes.

1.2 DEFINITIONS

- A. Product: As defined in Document 00700 – General Conditions. Product does not include machinery and equipment used for production, fabrication, conveying, and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. Process: Any proprietary system or method for installing system components resulting in an integral, functioning part of the Work. For this Section, the word Products includes Processes.

1.3 SELECTION OPTIONS

- A. Pre-approved Products: Construction products of certain manufacturers or Suppliers designated in Specifications as "pre-approved The Authority references the City of Houston list of pre-approved products for a comprehensive list of pre-approved products. Pre-approved Products for this Project are designated as pre-approved in Specifications. Products of other manufacturers or suppliers are not acceptable for this Project and will not be considered under the submittal process for approving alternate products.
- B. Pre-qualified Products: Construction products of certain manufacturers or Suppliers designated in Specifications as "pre-qualified." Pre-qualified Products for this Project are designated as pre-qualified in Specifications. Products of other manufacturers or suppliers are not acceptable for this Project and will not be considered under the submittal process for approving alternate products.
- C. Approved Products: Construction products of certain manufacturers or Suppliers designated in Specifications followed by words "or approved equal." Approval of alternate products not listed in Specifications may be obtained through provisions for product options and substitutions in Document 00700 - General Conditions, and by following submittal procedures specified in Section 01330- Submittal Procedures. The

procedure for approval of alternate products is not applicable to pre-approved or pre-qualified products.

- D. Product Compatibility: To the maximum extent possible, provide Products that are of the same type or function from a single manufacturer, make, or source. Where more than one choice is available, select Product that is compatible with other Products already selected, specified, or in use by the Authority.
- E. Engineer may reject requests for substitution, and his decision will be final and binding on the parties.

1.4 CONTRACTOR'S RESPONSIBILITY

- A. Investigate proposed product and determine that it meets or exceeds the quality level of the specified product.
- B. Furnish information Engineer deems necessary to judge equivalency of alternate Product.
- C. Pay for laboratory testing, as well as any other review or examination costs, needed to establish equivalency between products in order to obtain information upon which Engineer can base a decision.
- D. If Engineer determines alternate product is not equal to that named in Specifications, Furnish one of the specified Products.

1.5 AUTHORITY REVIEW

- A. Use alternate Products only when approved in writing by Engineer. Engineer's determination regarding acceptance of proposed alternate Product is final.
- B. Alternate Products shall be accepted if Products are judged by Engineer to be equivalent to specified Product or to offer substantial benefit to the Authority.
- C. The Authority retains the right to accept any Product deemed advantageous to the Authority, and similarly, to reject any product deemed not beneficial to Authority.

1.6 SUBSTITUTION PROCEDURE

- A. Collect and assemble technical information applicable to the proposed Product to aid in determining equivalency as related to the approved Product specified.
- B. Submit a written request for a construction Product to be considered as an alternate Product.
- C. Submit Product information after the effective date of the Contract and within the time

period allowed for substitution submittals given in Document 00700 - General Conditions. After the submittal period has expired, requests for alternate Products shall be considered only when specified Product becomes unavailable because of conditions beyond Contractor's control.

- D. Electronically submit each request for alternate Product approval in WHCRWA FTP site. Include the following information:
1. Complete data substantiating compliance of proposed substitution with the Contract.
 2. For Products:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature with Product description, performance and test data, and reference standards.
 - c. Samples, as applicable.
 - d. Name and address of similar projects on which Product was used and date of installation. Include names of Owner, DPOR, and installing contractor.
 3. For construction methods:
 - a. Detailed description of proposed method.
 - b. Drawings illustrating methods.
 4. Itemized comparison of proposed substitution with Product or method specified.
 5. Data relating to changes in Construction Schedule.
 6. Relation to separate contracts, if any.
 7. Accurate cost data on proposed substitution in comparison with Product or method specified.
 8. Other information requested by Engineer.
- E. Approved alternate Products will be subject to the same review process as the specified Product would have been for Shop Drawings, Product Data, and Samples.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

Section 01630

PRODUCT SUBSTITUTION PROCEDURES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Options for making Product or process selections.
- B. Procedures for proposing equivalent Products or processes, including pre-approved, pre-qualified, and approved Products or processes.

1.2 DEFINITIONS

- A. Product: Includes pre-fabricated or manufactured items designated for installation by the Construction Documents. Product does not include machinery and equipment used for production, fabrication, conveying, and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. Process: Any proprietary system or method for installing system components resulting in an integral, functioning part of the Work. For this Section, the word Products includes Processes.

1.3 SELECTION OPTIONS

- A. Pre-approved Products: Construction products of certain manufacturers or suppliers designated in the Specifications as "pre-approved". Pre-approved products consist of the City of Houston's current pre-approved products lists or products identified in the specification sections. Refer to <https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards> for the City's pre-approved products lists. In cases where a product is identified in the specification sections but not on the City's approved products lists, provide the products identified in the specification sections. Products of other manufacturers or suppliers may be submitted for approval as Alternate Products defined below.
- B. Alternate Products: Construction products of certain manufacturers or suppliers designated in the Specifications by words "or approved equal." Approval of alternate products not listed in Specifications or in the Pre-approved Products list may be obtained through provisions for product options and substitutions in the General Conditions of the Construction Contract, and by following submittal procedures specified in Section 01330- Submittal Procedures.
- C. Product Compatibility: To the maximum extent possible, provide Products that are of the

same type or function from a single manufacturer, make, or source. Where more than one choice is available, select Product that is compatible with other Products already selected, specified, or in use by the Authority.

- D. Engineer may reject requests for substitution, and his decision will be final and binding on the parties.

1.4 CONTRACTOR'S RESPONSIBILITY

- A. Investigate proposed product and determine that it meets or exceeds the quality level of the specified product.
- B. Furnish information Engineer deems necessary to judge equivalency of alternate Product.
- C. Pay for laboratory testing, as well as any other review or examination costs, needed to establish equivalency between products in order to obtain information upon which Engineer can base a decision.
- D. If Engineer determines alternate product is not equal to that named in Specifications, Furnish one of the specified Products.

1.5 ENGINEER'S REVIEW

- A. Use Alternate Products only when approved in writing by Engineer. Engineer's determination regarding acceptance of proposed Alternate Product is final.
- B. Alternate Products shall be accepted if Products are judged by Engineer to be equivalent to specified Product or to offer substantial benefit to the Authority.
- C. The Authority retains the right to accept any Product deemed advantageous to the Authority, and similarly, to reject any product deemed not beneficial to Authority.

1.6 SUBSTITUTION PROCEDURE

- A. Collect and assemble technical information applicable to the proposed Product to aid in determining equivalency as related to the approved Product specified.
- B. Submit a written request for a construction Product to be considered as an alternate Product.
- C. Submit Product information after the effective date of the Contract and in accordance with the General Conditions of the Construction Contract.. After the submittal period has expired, requests for Alternate Products shall be considered only when specified Product becomes unavailable because of conditions beyond Contractor's control.

- D. Electronically submit each request for Alternate Product approval in WHCRWA FTP site. Include the following information:
1. Complete data substantiating compliance of proposed substitution with the Contract.
 2. For Products:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature with Product description, performance and test data, and reference standards.
 - c. Samples, as applicable.
 - d. Name and address of similar projects on which Product was used and date of installation. Include names of Owner, DPOR, and installing contractor.
 3. For construction methods:
 - a. Detailed description of proposed method.
 - b. Drawings illustrating methods.
 4. Itemized comparison of proposed substitution with Product or method specified.
 5. Data relating to changes in Construction Schedule.
 6. Relation to separate contracts, if any.
 7. Accurate cost data on proposed substitution in comparison with Product or method specified.
 8. Other information requested by Engineer.
- E. Approved Alternate Products will be subject to the same review process as the specified Product would have been for Shop Drawings, Product Data, and Samples.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

Section 01725

FIELD SURVEYING

PART 1 G E N E R A L

1.1 QUALITY CONTROL

- A. Conform to State of Texas laws for surveys requiring licensed surveyors. Employ a surveyor acceptable to Engineer if required by the Contract.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. No separate payment will be made for field surveying. Include cost in unit price for related items.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit name, address, and telephone number of Surveyor to Engineer before starting survey work.
- C. Submit documentation verifying accuracy of survey work on request.
- D. Submit certificate signed by Surveyor, that elevations and locations of the Work are in conformance with the Contract.

1.4 PROJECT RECORD DOCUMENTS

- A. Maintain a complete and accurate log of control and survey work as it progresses.
- B. Prepare a certified survey setting forth dimensions, locations, angles, and elevations of construction and site work upon completion of foundation walls and major site improvements.
- C. Submit record documents under provisions of Section 01785 - Project Record Documents.

1.5 EXAMINATION

- A. Verify locations of survey control points prior to starting the Work.

- B. Notify Engineer immediately if any discrepancies are discovered.

1.6 SURVEY REFERENCE POINTS

- A. The Authority will establish survey control datum as indicated on Drawings. Inform Engineer in advance of time horizontal and vertical control points will be established so verification deemed necessary by Engineer may be done with minimum inconvenience.
- B. Locate and protect survey control points prior to starting site work; preserve permanent reference points during construction.
- C. Notify Engineer a minimum of 48 hours before relocation of reference points is needed due to changes in grades or other reasons.
- D. Promptly report loss or destruction of reference points to Engineer.
- E. Reimburse the Authority for cost of reestablishment of permanent reference points disturbed by construction operations.

1.7 SURVEY REQUIREMENTS

- A. Utilize recognized engineering survey practices.
- B. Establish a minimum of two permanent benchmarks on site, referenced to established control points. Record horizontal and vertical location data on Project record documents.
- C. Establish elevations, lines and levels to provide quantities required for measurement and payment and for appropriate controls for the Work. Locate and lay out the following with appropriate instruments:
 - 1. Site improvements including grading, fill and topsoil placement, utilities, and footings and slabs
 - 2. Grid or axis for structures
 - 3. Building foundation, column locations, and ground floor elevations
- D. Periodically verify layouts.

PART 2 P R O D U C T S – Not Used

PART 3 E X E C U T I O N – Not Used

END OF SECTION

Section 01731

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cutting, patching and fitting of the Work or work under construction. Coordinating Installation or connection of the Work to existing facilities, or uncovering work for access, inspection or testing and related submittals.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. No separate payment will be made for cutting and patching. Include cost in unit price for related items.

1.3 CUTTING AND PATCHING

- A. Perform activities to avoid interference with facility operations and work of others in accordance with the General Conditions of the Construction Contract.
- B. Execute cutting and patching, including excavation, backfill and fitting to:
 - 1. Remove and replace defective work or work not conforming to Drawings and Specifications;
 - 2. Take samples of installed work as required for testing;
 - 3. Remove construction required to provide for specified alterations or additions to existing work;
 - 4. Uncover work to allow inspection or reinspection by Engineer or regulatory agencies having jurisdiction;
 - 5. Connect uninstalled work to completed work in proper sequence;
 - 6. Remove or relocate existing utilities and pipes that obstruct work;
 - 7. Make connections or alterations to existing or new facilities;
 - 8. Provide openings, channels, chases and flues and cut, patch, and finish; if

required; or

9. Provide protection for other portions of the Work.
- C. Restore existing work to a condition equal to or better than that which existed prior to cutting and patching, and to standards required by Specifications.
- D. Support, anchor, attach, match, trim and seal materials to work of others. Unless otherwise specified, Furnish and Install sleeves, inserts, and hangers required for execution of the Work.
- E. Provide shoring, bracing and support necessary to maintain structural integrity and to protect adjacent work from damage during cutting and patching. Request written approval from Engineer, before cutting structural members such as beams, anchors, lintels, or other supports. Follow approved submittals, as applicable.
- F. Match new materials to existing materials by bonding, lapping, mechanically tying, anchoring or other effective means in order to prevent cracks and to minimize evidence of patching. Conceal effects of demolition and patching by blending new construction to existing surfaces. Avoid obvious breaks, joints or changes of surface appearance unless shown on Drawings or authorized by Engineer.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit a written request to Engineer for consent to proceed, before conducting cutting operations that might affect structural integrity, design function, Authority operations, or work of another contractor.
- C. Include the following in submittal:
 1. Identification of Project
 2. Description of affected work
 3. Necessity for cutting
 4. Effect on other work and on structural integrity
 5. Describe the proposed work including:
 - a. Scope of cutting and patching
 - b. Contractor, Subcontractor or Supplier who will execute the work

- c. Proposed Products
 - d. Extent of refinishing
 - e. Schedule of operations
- 6. Alternatives to cutting and patching
- D. When work conditions or schedules dictate the need for change of materials or methods, submit a written recommendation to Engineer that includes:
 - 1. conditions necessitating the change;
 - 2. recommendations for alternative materials or methods; and
 - 3. submittals required for proposed substitutions
- E. Notify Engineer in writing when work will be uncovered for observation. Do not begin cutting or patching operations until authorized by Engineer.

1.5 CONNECTIONS TO EXISTING FACILITIES

- A. Perform construction operations necessary to complete connections and tie-ins to existing facilities. Keep existing facilities in continuous operation unless otherwise permitted in the Specifications or approved in writing by Engineer.
- B. Coordinate interruption of service requiring connection to existing facilities with Engineer. Do not bypass wastewater or sludge to waterways. Provide temporary pumping facilities to handle wastewater if necessary. Use temporary bulkheads to minimize disruption. Provide temporary power and piping to facilitate construction where necessary.
- C. Submit a detailed schedule of proposed connections, including shut-downs and tie-ins. Include proposed time and date as well as anticipated duration of work. Coordinate the connection schedule with the construction schedule.
 - 1. Submit specific times and dates to Engineer at least 48 hours in advance of proposed work.
- D. Procedures and Operations:
 - 1. Operate existing pumps, valves and gates in required sequence under supervision of Engineer. Do not operate valves, gates or other items of equipment without Engineer's knowledge.
 - 2. If possible, test equipment under operating conditions before making final tie-ins

to connect equipment to existing facility.

3. Coordinate work and schedules. Notify Engineer at least 48 Hours before shutdowns or bypasses are required.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01732

PROCEDURE FOR WATER VALVE ASSISTANCE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Operation of valves: Authority employees will operate existing valves. Contractor's employees may operate new valves included in the Project prior to acceptance by the Authority.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for this item. Include the cost of valve operation and valve assistance in Unit Price bid for valves and water mains.

1.03 PROCEDURE

- A. Contractor to coordinate with Engineer, operator, and Resident Project Representative for valve assistance.

1.04 SUBMITTALS

- A. Submit request for work order planning meetings in accordance with Section 01330 – Submittal Procedures.

1.05 CANCELLATION

- A. The Authority may cancel a scheduled valve assistance appointment at no extra cost to either party. Cancellation may be caused by bad weather, preparation work taking longer than anticipated or unforeseen delays by one or more of the three parties.

PART 2 P R O D U C T S -Not Used

PART 3 E X E C U T I O N -Not Used

END OF SECTION

Section01755

STARTING SYSTEMS

PART1 GENERAL

1.1 SECTION INCLUDES

- A. Starting systems.
- B. Demonstration and instructions.
- C. Testing, adjusting and balancing.

PART2 PRODUCTS - Not Used

PART3 EXECUTION

3.1 PREPARATION

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Engineer seven days prior to startup of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other damage-causing conditions.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision in accordance with manufacturer's instructions.
- G. When specified in individual Specification sections, require manufacturer to provide an authorized representative to be present at the site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit written report indicating that equipment or system has been properly installed and is functioning correctly.

3.2 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of Products to Engineer two weeks prior to Date of Substantial Completion.
- B. Utilize O&M Manuals as the basis for instruction. Review contents of manual with Engineer in detail to explain aspects of operation and maintenance.
- C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at the equipment location.
- D. Prepare and insert additional data in O&M Manuals when the need for additional data becomes apparent during instruction.
- E. At a minimum, Contractor will demonstrate the following:
 - 1. Products and procedures to be used in maintaining various surfaces, e.g., counter tops, toilet partitions, tile floors and carpeting;
 - 2. procedures to set and maintain landscape irrigation system;
 - 3. procedures to set and maintain security and fire alarm systems; and
 - 4. procedures to set and maintain HVAC systems.

3.3 TESTING, ADJUSTING AND BALANCING

- A. Contractor shall appoint, employ and pay for the services of an independent firm to perform testing, adjusting and balancing.
- B. Submit reports by the independent firm to Engineer describing observations and results of tests and signifying compliance or non-compliance with specified requirements and requirements of the Contract.

END OF SECTION

Section 01770

CLOSEOUT PROCEDURES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Substantial Completion Procedures.
- B. Closeout procedures for final submittals, operation and maintenance data, warranties, spare parts, and maintenance materials.
- C. Texas Department of Licensing and Regulation (TDLR) inspection for ADA compliance.

1.02 SUBSTANTIAL COMPLETION

- A. Comply with Document - General Conditions and Supplemental Conditions of the contract regarding substantial completion when Contractor considers the Work, or portion thereof designated by Engineer, to be substantially complete.
- B. Insure the following items have been completed when included in the Work, prior to presenting a list of items to be inspected by Engineer for issuance of a Certificate of Substantial Completion:
 - 1. cutting, plugging, and abandoning of water, wastewater, and storm sewer lines, as required by specifications for each item;
 - 2. construction of, and repairs to, pavement, driveways, sidewalks, and curbs and gutters;
 - 3. sodding and hydromulch seeding, unless waived by the Authority in writing;
 - 4. general clean up including pavement markings, transfer of services, successful testing and landscape;
 - 5. installation of all bid items included in Bid Form
 - 6. additional requirements in Section 01110 - Summary of Work.
 - 7. quality control testing has been submitted and passed
 - 8. permits are up-to-date
 - 9. All known issues and claims from the public or regulatory entities have been resolved

- C. Assist Engineer with inspection of Contractor's list of items and complete or correct the items, including items added by Engineer, within a time period of 30 days or as mutually agreed.
- D. Should Engineer's inspection show failure of Contractor to comply with substantial completion requirements, including those items in Paragraph 1.02B of this specification, Contractor shall complete or correct the items, before requesting another inspection by Engineer.

1.03 CLOSEOUT PROCEDURES

- A. Comply with Document General Conditions and Supplemental Conditions of the contract regarding Final Completion and Final Payment when Work is complete and ready for Engineer's final inspection.
- B. Provide Project Record Documents in accordance with Section 01785 - Project Record Documents.
- C. Complete or correct items on punch list, with no new items added. Address new items during warranty period.
- D. Authority will occupy portions of Work as specified in other Sections.

1.04 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. For facilities, clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to sanitary condition.
- D. Clean or replace filters of operating equipment.
- E. Clean debris from roofs, gutters, down spouts, and drainage systems.
- F. Clean site; sweep paved areas, rake landscaped surfaces clean.
- G. Remove waste and surplus materials, rubbish, and temporary construction facilities from site following final test of utilities and completion of Work.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit operations and maintenance data as noted in Section 01330 - Submittal Procedures.

1.07 WARRANTIES

- A. Provide one original and two copies of each warranty from subcontractors, suppliers, and manufacturers.
- B. Provide Table of Contents and assemble warranties in three-ring/D binder with durable plastic cover.
- C. Submit warranties prior to final progress payment.
- D. Warranties shall commence in accordance with requirements in Document- General Conditions and Supplemental Conditions of the contract.

1.08 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance, and extra materials in quantities specified in individual Specification sections.
- B. Deliver to location as directed by Engineer; obtain receipt prior to final Payment Application.

1.09 TEXAS DEPARTMENT OF LICENSING AND REGULATION (TDLR)
INSPECTION

- A. Contact TDLR's Houston Regional Office, 5425 Polk Street, Houston, Texas, 77023, telephone 713-924-6303, fax 713-921-3106, to schedule an inspection for ADA compliance prior to final completion.
- B. Provide results of TDLR's inspection to Engineer prior to final inspection.

1.10 FINAL PHOTOS

Provide per Specification Section 01321 - Construction Photographs.

1.11 PROJECT RECORD DOCUMENTS

Provide per Specification Section 01785 - Project Record Documents.

PART 2 P R O D U C T S (NOT USED)

PART 3 E X E C U T I O N (NOT USED)

END OF SECTION

Section 01782

OPERATIONS AND MAINTENANCE DATA

PART 1 G E N E R A L

1.01 SECTION INCLUDES

Submittal requirements for equipment and facility operating and maintenance manuals

1.02 MEASUREMENT AND PAYMENT

No separate payment for submittals unless approved in the Schedule of Values

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures. Submit list of operation and maintenance manuals and parts manuals to be provided.
- B. Submit documents, bound in 8½- x 11-inch text pages, three-ring/D binders with durable plastic covers.
- C. Prepare binder covers with printed title
“OPERATION AND MAINTENANCE INSTRUCTIONS,”
Title of project and subject matter of binder when multiple binders are required.
- D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Contents: Prepare Table of Contents for each volume, with each Product or system description identified.
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system. For each category, identify names, addresses, and telephone numbers of subcontractors and suppliers. Identify following:
 - a. Significant design criteria
 - b. List of equipment
 - c. Parts list for each component
 - d. Operating instructions
 - e. Maintenance instructions for equipment and systems

- f. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents
- 3. Part 3: Project documents and certificates, including following:
 - a. Shop drawings and product data
 - b. Testing reports
 - c. Certificates
 - d. Photocopies of warranties

F. Within 1 month prior to placing equipment or facility in service, submit one original and two copies of operation and maintenance manual and parts manual for review. In conjunction with hard copies, submit in *.PDF format in document management software.

G. Submit one original and two copies of completed volumes in final form 10 days prior to final inspection. This will be returned after final inspection, with Engineer's comments. Revise content of documents as required prior to final submittal. In conjunction with hard copies, submit in *.PDF format in document management software.

H. Revise and resubmit final volumes (three each) within 10 days after final inspection.

I. Provide the final approved manuals in *.PDF format in the document management system.

1.04 EQUIPMENT OPERATION AND MAINTENANCE DATA

A. Furnish operation and maintenance manuals for equipment. Operation and maintenance manual must contain all information required for the Authority to operate, maintain, and repair equipment. Manual must be prepared by equipment manufacturer, furnished to Engineer and, as minimum, contain following:

- 1. Equipment functions, normal operating characteristics and limiting conditions
- 2. Assembly, installation, alignment, adjustment, and checking instructions
- 3. Operating instructions for start-up, normal operation, regulation and control, normal shutdown and emergency shutdown
- 4. Lubrication and detailed maintenance instructions. Maintenance instructions are to include detailed drawings giving location of each maintainable part and lubrication point and detailed instructions on disassembly and reassembly of equipment
- 5. Troubleshooting guide
- 6. Complete spare parts list with predicted life of parts subject to wear, lists of spare parts recommended on hand for both initial start-up and for normal operating inventory, and local or nearest source of spare parts availability
- 7. Outline, cross-section, and assembly drawings; engineering data; wiring diagram
- 8. Test data and performance curves

- B. Furnish parts manuals for equipment. Manual must be prepared by equipment manufacturers, furnished to Engineer and, as minimum, contain following:
1. Detailed drawings giving location of each maintainable part
 2. Complete spare parts list with predicted life of parts subject to wear, lists of spare parts recommended on hand for both initial start-up and for normal operating inventory, and local or nearest source of spare parts availability

PART 2 P R O D U C T S (NOT USED)

PART 3 E X E C U T I O N (NOT USED)

END OF SECTION

Section 01785

PROJECT RECORD DOCUMENTS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

Maintenance and Submittal of Record Documents and Samples.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Maintain one record copy of documents at site in accordance with the Supplemental Conditions of the Contract.
- B. Store Record Documents and samples in field office when field office is required by Contract, or in secure location. Provide files, racks, and secure storage for Record Documents and samples.
- C. Label each document "PROJECT RECORD" in neat, large, printed letters.
- D. Maintain Record Documents in clean dry and legible condition. Do not use Record Documents for construction purposes.
- E. Keep Record Documents and Samples available for inspection by Resident Project Representative.
- F. Bring Record Documents to progress review meetings for viewing by Resident Project Representative. After each progress review meeting, update Contract Drawings using owner provided document management system and save update as "Project Record Drawing" on (insert date).

1.03 RECORDING

- A. Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- B. Contract Drawings and Shop Drawings: On actual documents and on Project Record Drawing, legibly mark each item to record actual construction, or "as built" conditions, including:
 - 1. Measured depths of elements of foundation in relation to finish first floor datum
 - 2. Measured horizontal locations and elevations of underground utilities and appurtenances, referenced to permanent surface improvements
 - 3. Elevations of underground utilities referenced to bench mark utilized for Project
 - 4. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction

5. Field changes of dimension and detail
 6. Changes made by modifications
 7. Details not on original Contract Drawings
 8. References to related shop drawings and modifications
 9. Locations, elevation and station of other utilities not shown on contract drawings and encountered during construction.
- C. Maintain on site at all times an instrument for accurately measuring elevations. Survey every joint of water main at time of construction and record on drawings water main invert elevation, including elevation top of manway and centerline horizontal location relative to baseline.
- D. Record information with red felt-tip marking pen on set of construction drawings.
- E. For large diameter water mains, legibly mark specifications and addenda to record:
1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
 2. Changes made by change order or field order.
 3. Other matters not originally specified.
- F. Legibly annotate shop drawings to record changes made after review.
- G. In addition to record drawings, at Contract Closeout, make all as-built comments and changes to contract drawings and submit to owner provided document management system in *.PDF format.

1.04 SUBMITTALS

At Contract closeout, input Project Record Documents into owner provided document management system in *.PDF format and deliver original Documents to Engineer.

PART 2 P R O D U C T S (NOT USED)

PART 3 E X E C U T I O N (NOT USED)

END OF SECTION

Section 02081

CAST-IN-PLACE CONCRETE MANHOLES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Cast-in-place concrete manholes for sanitary sewers, water lines and storm sewers, including box sewers.
- B. Pile-supported concrete foundation used for unstable subgrade treatment for manhole base.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for manholes is on a unit price basis for each manhole installed.
 - 2. Payment for Type C manhole with BB inlet top is on a unit price basis for each.
 - 3. Payment for pile-supported concrete foundation used for unstable subgrade treatment for manhole base is on a unit price basis for each foundation installed.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASME B 16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- B. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod, 60,000 psi Tensile Strength.
- C. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
- D. ASTM C 923 - Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
- E. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

- F. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic - Cement Grout (Non-shrink).
- G. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 KN-m/m³)).
- H. ASTM D 2665 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe, and Fittings.
- I. ASTM D 2996 - Standard Specification for Filament-wound Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- J. ASTM D 2997 - Standard Specification for Centrifugally Cast Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- K. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile – Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
- L. ASTM F 2510 – Standard Specification for Resilient Connectors Between Concrete Manhole Structures and Corrugated Dual and Triple – Wall Polyethylene and Polypropylene Pipes.
- M. AWWA C 213 – Fusion-Bonded Epoxy Coating and Linings for Steel Water Pipe and Fittings.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed design mix and test data for each type and strength of concrete.
- C. Submit manufacturer's data and details of following items for approval:
 - 1. Frames, grates, rings, and covers.
 - 2. Materials to be used in fabricating drop connections.
 - 3. Materials to be used for pipe connections at manhole walls.
 - 4. Materials to be used for stubs and stub plugs.
 - 5. Plugs to be used for sanitary sewer hydrostatic testing.
 - 6. Installation instructions for forms.

- D. Submit structural design calculations, signed and sealed by a licensed Engineer.

PART 2 P R O D U C T S

2.1 CONCRETE

- A. Conform to requirements of Section 03315 - Concrete for Utility Construction.
- B. Provide Class A concrete with minimum compressive strength of 4000 psi unless otherwise indicated on Drawings.
- C. Design Loading Criteria: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed, by manufacturer, to requirements of ASTM C 478, ASTM C 890, and/or ASTM C 913 for depth as shown on Drawings and to resist following loads.
1. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design Specifications applied to manhole cover and transmitted down to transition and base slabs.
 2. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections.
 3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf.
 4. Internal liquid pressure based on unit weight of 63 pcf.
 5. Dead load of manhole sections fully supported by transition and base slabs.
- D. Design: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed according to requirements of ASTM C 478, ASTM C 890 and/or ASTM C 913 and following:
1. Design additional reinforcing steel to transfer stresses at openings. Area of steel to be no less than shown on Drawings.
 2. Wall loading conditions:
 - a. Saturated soil pressure acting on empty manhole.
 - b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure.
 3. Minimum clear distance between two wall penetrations shall be 12 inches or half diameter of smaller penetration, whichever is greater

2.2 REINFORCING STEEL

- A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

2.3 MORTAR

- A. Conform to requirements of Section 04061 - Mortar

2.4 MISCELLANEOUS METALS

- A. Provide cast-iron frames, grates, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

2.5 DROP CONNECTIONS AND STUBS

- A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.6 PIPE CONNECTIONS

- A. Sanitary Sewers.

1. Provide resilient connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:
 - a. External clamps: Type 304 stainless steel
 - b. Internal, expandable clamps on Standard manholes: Type 304 stainless steel, 11 gauge minimum
 - c. Internal, expandable clamps on corrosion-resistant manholes:
 - (1) Type 316 stainless steel, 11 gauge minimum
 - (2) Type 304 stainless steel, 11 gauge minimum, coated with minimum 16 mil fusion-bonded epoxy conforming to AWWA C213
2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene waterstop meeting physical property requirements of ASTM C 923, such as Pres-Seal WS Series, or approved equal.

- B. Storm Sewers: Connections of concrete pipe to manhole will be set in flexible joint sealant conforming to ASTM C 990, placed in the middle of the manhole wall and covering the lower 1/3rd of the opening. Use non-shrink grout for storm sewer pipe connections to

concrete manholes, unless otherwise shown on Drawings. Grout pipe penetration in place on both inside and outside of manhole.

C. Water Lines

1. Where smooth exterior pipes, i.e., steel, ductile iron, or PVC pipes are connected to manhole base or barrel, seal space between pipe and manhole wall with assembly consisting of rubber gasket or links mechanically compressed to form a watertight barrier. Assemblies: Press-Wedge, Pres-Seal, Thunderline, Link-Seals, Advance Products & Systems InnerLynx, or approved equal. See Drawings for placement of assembly in manhole sections.
2. When connecting concrete or cement mortar coated steel pipes, or as option for connecting exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of a stainless steel power sleeve, stainless steel take-up clamp and a rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.

2.7 SEALANT MATERIALS

- A. Provide sealing materials between precast concrete adjustment ring and manhole cover frame, such as Adeka Ultraseal P 201, or approved equal.
- B. Provide external sealing material from Canusa Wrapid Seal manhole encapsulation system, or approved equal.
- C. Butyl Sealant: Provide Press-Seal EZ Stick, or equal, for HDPE rings.

2.8 CORROSION-RESISTANT MANHOLE MATERIALS

- A. Where corrosion-resistant manholes are indicated on the Drawings, refer to City of Houston's Approved Products List for liner and/or coating materials.

2.9 BACKFILL MATERIALS

- A. Conform to the requirements of Section 02317 - Excavation and Backfill for Utilities.

2.10 NON-SHRINK GROUT

- A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based non-shrink grout requiring only addition of water.
- B. Provide grout meeting requirements of ASTM C 1107 and having minimum 28-day compressive strength of 7000 psi.

2.11 VENT PIPES

- A. Provide external vent pipes for manholes where indicated on Drawings.
- B. Buried Vent Pipes: Provide 3 inch or 4 inch PVC DWV pipe conforming to ASTM D 2665. Alternatively, provide FRP pipe as specified for vent outlet assembly.
- C. Vent Outlet Assembly: Provide vent outlet assembly as shown on Drawings, constructed of following specified materials:
 - 1. FRP Pipe: Provide filament-wound FRP conforming to ASTM D 2996 or centrifugally cast FRP conforming to ASTM D 2997. Seal cut ends in accordance with manufacturer's recommendations.
 - 2. Joints and Fittings: Provide epoxy- bodied fittings and join pipe to fittings with epoxy adhesive, according to pipe manufacturer's instructions.
 - 3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on Drawings. Meet bolt pattern and dimensions for ASME B 16.1, 125- pound flanges. Use Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B flange bolts.
 - 4. Coating: Provide 2-component, aliphatic polyurethane coating, using primer or tie coat recommended by manufacturer. Provide two or more coats to yield dry film thickness of at least 3 mils. Provide Amershield, Tnemec 74, or approved equal. Engineer selects color from manufacturer's standard colors.

2.12 MANHOLE LADDERS

- A. Provide ladders for manholes in accordance with requirements noted in details on the Drawings.
- B. Refer to Drawings for ladder material.
- C. Refer to Section 05510 – Metal Fabrications or Section 06610 – FRP Fabrications for ladder material and installation requirements.
- D. Provide ladder safety or personal fall-arrest system for ladders that extend 24 feet or greater. Ladder safety system shall be SAF-T-CLIMB as manufactured by Honeywell Miller, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify lines and grades are correct.

- B. Determine if subgrade, when scarified and re-compacted, can be compacted to 95 percent of maximum Standard Proctor Density at ± 3 percent optimum moisture content according to ASTM D 698 prior to placement of material and base section. If it does not meet the moisture-density requirement, condition the subgrade until the required moisture-density requirement is met or treat as an unstable subgrade.
- C. Do not build manholes in ditches, swales, or drainage paths unless approved by Engineer.

3.2 MANHOLES

- A. Construct manholes to dimensions shown on Drawings. Commence construction as soon as possible after pipes are laid. On monolithic sewers, construct manholes at same time sewer is being constructed.
- B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify Engineer for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24-inch-thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.
- C. Cast manhole foundations and walls monolithically. Use cold joint with approved waterstop when manhole flow line depth exceeds 12 feet. No other joints will be allowed unless shown on Drawings. Wrap cold joints with external sealing material, minimum 6-inch with.
- D. For concrete containing micro silica admixtures, place, finish, and cure concrete for manholes following procedures in Section 03315 - Concrete for Utility Construction
- E. Top of manhole elevations shown on Drawings are approximate, based on current pavement and natural ground conditions as determined from elevations measured on 50-foot spacing. No additional payment will be made if final elevation of manhole ring and cover is higher or lower due to requirements of finished grade or replaced pavement surface.
- F. For water lines place concrete for manhole base on 12" thick (minimum) foundation of cement stabilized sand. Compact cement stabilized sand in accordance with requirements of 02321 – Cement Stabilized Sand.
- G. For manholes located over large diameter water lines, place base on a foundation of cement stabilized sand extending from bottom of manhole to bottom of trench. Manhole base is to be a minimum of 12-inches above water line.

3.3 PIPE CONNECTIONS

- A. Install approved resilient connectors at each pipe entering and exiting water line and sanitary sewer manholes in accordance with manufacturer's instructions.

- B. Storm sewer connections of concrete pipe to manhole will be set in flexible joint sealant conforming to ASTM C 990, placed in the middle of the manhole wall and covering the lower 1/3rd of the opening. Grout pipe penetrations both inside and outside of manhole.
- C. Ensure no concrete, cement stabilized sand, fill, or other solid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on interior or exterior of manhole. When necessary, fill space with compressible material to ensure resilient connector will maintain full flexibility where evidence of reduced flexibility is encountered.
- D. Where new manhole is to be constructed on existing sewer, a rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe spring line using adhesive recommended and supplied by waterstop manufacturer.
- E. Do not construct joints on sanitary sewer pipe within wall sections of manholes. Use approved connection material.
- F. Construct pipe stubs with resilient connectors for future connections at locations and with material indicated on Drawings. Install approved stub plugs at interior of manhole.
- G. Test connection for watertight seal before backfilling.

3.4 INVERTS FOR SANITARY SEWERS

- A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to the following criteria:
 - 1. Slope of invert bench: 1 inch per foot minimum; 1 1/2 inch per foot maximum.
 - 2. Depth of bench to invert:
 - a. Pipes smaller than 15 inches: one-half of largest pipe diameter
 - b. Pipes 15 to 24 inches: three-fourths of largest pipe diameter
 - c. Pipes larger than 24 inches: equal to largest pipe diameter
 - 3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of flow at pipe-manhole connections. Conform to following criteria.
- B. Form invert channels with Class A concrete if not integral with manhole base. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.5 INVERTS FOR STORM SEWERS

- A. When precast, square or rectangular structures are used for sewer manholes, construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe manhole connections. Conform to following criteria:
 - 1. Slope of invert bench: 1 inch per foot minimum; 1½ inches per foot maximum.
 - 2. Depth of bench to invert: one half of largest pipe diameter.
 - 3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on drawings.
- B. Form invert channels with concrete, after all connections have been made.
 - 1. Use 5 sack premix (bag) concrete or Class A concrete for inverts, with minimum compressive strength of 4,000 psi.

3.6 DROP CONNECTIONS FOR SANITARY SEWERS

- A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement-stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4 inches outside bells.
- B. Install connection when sewer line enters manhole higher than 24 inches above invert of manhole.

3.7 STUBS FOR FUTURE CONNECTIONS

- A. In manholes where future connections are indicated on Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.8 ADJUSTMENT RINGS AND FRAME

- A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces to be joined with non-shrink grout. Set cast iron frame on adjustment ring in a bed of approved sealant material. Install a sealant bed consisting of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.
- B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame, and ring and precast section.

- C. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. Encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.9 BACKFILL

- A. After concrete obtains adequate strength, place and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities. Use embedment zone backfill material for adjacent utilities, as shown in Details over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.
- B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to spring line of pipe with Class B concrete or flowable fill.
- C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.
- D. Provide minimum of 4 inches of topsoil conforming to requirements of Section 02911 - Topsoil.
- E. Seed in accordance with Section 02921 - Hydro-mulch Seeding, or sod disturbed areas in accordance with Section 02922 - Sodding.

3.10 FIELD QUALITY CONTROL

- A. Conduct leakage testing of Sanitary Sewer manholes in accordance with requirements of Section 02533 - Acceptance Testing for Sanitary Sewers.

3.11 PROTECTION

- A. Protect manholes from damage until subsequent work has been accepted. Repair or replace damaged elements of manholes at no additional cost to Authority.

END OF SECTION

Section 02082

PRECAST CONCRETE MANHOLES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Precast concrete manholes for sanitary sewers, storm sewers, and water lines. Manhole bases may be round or square.
- B. Precast concrete sanitary sewer manholes with PVC liner where corrosion resistant manholes are specifically indicated in Drawings.
- C. Pile-supported concrete foundation used for unstable subgrade treatment for manhole base.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. Payment for normal depth manholes, up to 8 feet deep, is on a unit price basis for each manhole installed. Manhole depth is measured from top of cover to sewer invert. Air release manhole depth is measured from top of cover to inside base for air release or vacuum release manholes. Manholes for water lines are measured from top of cover to inside base of manhole.
- 2. Payment for shallow depth manholes is on a unit price basis for each manhole installed. Shallow manholes have a depth of 5 feet or less measured from top of Title cover to sewer invert.
- 3. Payment for extra depth manholes is on a unit price basis per vertical foot for each foot of depth greater than 8 feet. Sewer manhole depth is measured from top of cover to sewer invert. Air release manhole depth is measured from top of cover to inside base for air release or vacuum release manholes. Manholes for water lines are measured from top of cover to inside base of manhole.
- 4. Payment for normal depth corrosion resistant manholes is on a unit price basis for each manhole installed.
- 5. Payment for standard manhole drops is on a unit price basis for each drop installed. Standard manhole drops include both internal and external drops.
- 6. Payment for watertight manholes, including external vent pipe is on a unit price basis for each.

7. Payment for air-release manhole with valves and fittings installed is on a unit price basis for each manhole with air-release valves and fittings installed.
8. Payment for pile-supported concrete foundation used for unstable subgrade treatment for manhole base is on a unit price basis for each foundation installed.
9. Pay estimates for partial payments will be made as measured above according to the following schedule for sanitary sewer manholes:
 - a. Estimate for 90 percent payment will be authorized when the manhole is completely installed and surrounding soil backfilled
 - b. Estimate for 100 percent payment will be authorized when manhole has been tested as specified in Section 02533 - Acceptance Testing for Sanitary Sewers
10. Refer to Section 01270 - Measurement and Payment for unit price procedures

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASME B 16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
- B. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
- C. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- D. ASTM C 270 - Standard Specification for Mortar for Unit Masonry
- E. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- F. ASTM C 478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
- G. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
- H. ASTM C 913 — Standard Specifications for Precast Concrete Water and Wastewater Structures.
- I. ASTM C 923 - Standard Specifications for Resilient Connectors Between Reinforced

Concrete Manhole Structures, Pipes, and Laterals

- J. ASTM C 990 — Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
 - K. ASTM C 1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - L. ASTM C 1821 - Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures
 - M. ASTM C 1837 – Standard Specification for Production of Dry Cast Concrete Used for Manufacturing Pipe, Box, and Precast Structures
 - N. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³))
 - O. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings
 - P. ASTM D 2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
 - Q. ASTM D 2997 - Standard Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
 - R. ASTM F 2306 — Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
 - S. ASTM F 2510 — Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
 - T. AWWA C 213 - Fusion Bonded Epoxy Coatings for Steel Water Pipe and Fittings
 - U. American Association of State Highway and Transportation Officials (AASHTO)
- 1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 - Submittal Procedures.
 - B. Submit manufacturer's data and details of following items for approval:
 - 1. Shop drawings of manhole sections, base units and construction details, including reinforcement, jointing methods, materials and dimensions.

2. Summary of criteria used in manhole design including, as minimum, material properties, loadings, load combinations, and dimensions assumed. Include certification from manufacturer that precast manhole design is in full accordance with ASTM C 478 and/or ASTM C 890 and design criteria as established in Paragraph 2.01E of this Specification.
 3. Frames, grates, rings, and covers
 4. Materials to be used in fabricating drop connections
 5. Materials to be used for pipe connections at manhole walls
 6. Materials to be used for stubs and stub plugs, if required
 7. Materials and procedures for corrosion-resistant liner and coatings, if required.
 8. Plugs to be used for sanitary sewer hydrostatic testing
 9. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches
- C. Seal submittal drawings by Professional Engineer registered in State of Texas.

PART 2 P R O D U C T S

2.1 PRECAST CONCRETE MANHOLES

- A. Provide manhole sections, base sections, and related components conforming to ASTM C 478. Provide base riser section with integral floors, unless shown otherwise. Provide adjustment rings which are standard components of manufacturer of manhole sections. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.
- B. Construct barrels for precast manholes from standard reinforced concrete manhole sections of diameter indicated on Drawings. Use various lengths of manhole sections in combination to provide correct height with fewest joints. Design wall sections for depth and loading conditions in Paragraph 2.1 E, with minimum thickness of 5 inches. Base section shall have minimum thickness of 12 inches under invert.
- C. Provide tops to support cast iron casting meeting AASHTO M-306 Section 5 loading, and receive manhole frame & covers, as indicated on Drawings.
- D. Where manholes larger than 48-inch diameter are indicated on Drawings, provide precast base sections with flat slab top precast sections used to transition to 48-inch diameter manhole access riser sections. Transition can be concentric or eccentric unless otherwise

shown on Drawings. Locate transition to provide minimum of 7-foot head clearance from base to underside of transition unless otherwise approved by the Engineer.

- E. Design Loading Criteria: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed, by manufacturer, to requirements of ASTM C 478, ASTM C 890 and/or ASTM C 913 for depth as shown on Drawings and to resist following loads.
 - 1. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design Specifications applied to manhole cover and transmitted down to transition and base slabs
 - 2. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections
 - 3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf
 - 4. Internal liquid pressure based on unit weight of 63 pcf
 - 5. Dead load of manhole sections fully supported by transition and base slabs
- F. Design: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed according to requirements of ASTM C 478, ASTM C 890 and/or ASTM C 913 and following:
 - 1. Design additional reinforcing steel to transfer stresses at openings. Area of steel to be no less than shown on Drawings.
 - 2. Wall loading conditions:
 - a. Saturated soil pressure acting on empty manhole
 - b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure
 - 3. Minimum clear distance between two wall penetrations shall be 12 inches or half diameter of smaller penetration, whichever is greater
- G. Provide joints between sections with gaskets conforming to ASTM C 443 and/or ASTM C-990.
- H. When base is cast monolithic with portion of vertical section, extend reinforcing in vertical section into base.
- I. Precast Concrete Base: Suitable cutouts or holes to receive pipe and connections. Lowest edge of holes or cutouts: For water line manhole, no less than 6 inches above inside surface

of floor of base.

2.2 CONCRETE

- A. Conform to requirements of Section 03315 - Concrete for Utility Construction or ASTM C 1837.
- B. Channel Inverts: Use 5 sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of 4,000 psi.
- C. Cement Stabilized Sand Foundation: Provide cement stabilized sand foundation under base section in lieu of foundation slab, as shown on Drawings, conforming to requirements of Section 02321 - Cement Stabilized Sand.
- D. Concrete Foundation: Provide Class A concrete with minimum compressive strength of 4,000 psi for concrete foundation slab under manhole base section where indicated on Drawings.

2.3 REINFORCING STEEL

- A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

2.4 MORTAR

- A. Conform to requirements of Section 04061 - Mortar.

2.5 MISCELLANEOUS METALS

- A. Provide cast-iron frames, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings and Covers.
- B. Provide aluminum ladders where indicated conforming to the fabrication requirements of Section 05501 – Metal Fabrications.

2.6 DROP CONNECTIONS AND STUBS

- A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.7 PIPE CONNECTIONS TO MANHOLE

- A. Sanitary Sewers
 - 1. Provide resilient connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:

- a. External clamps: Type 304 stainless steel
- b. Internal, expandable clamps on standard manholes: Type 304 stainless steel, 11 gauge minimum.
- c. Internal, expandable clamps on corrosion-resistant manholes:
 - i. Type 316 stainless steel, 11 gauge minimum
 - ii. Type 304 stainless steel, 11 gauge minimum, coated with minimum 16 mil fusion-bonded epoxy conforming to AWWA C 213
- 2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene water-stop meeting physical property requirements of ASTM C 923, such as Press-Seal WS Series, or approved equal.
- B. Storm Sewer Connections:
 - 1. Provide watertight connections in accordance with ASTM C 923 and ASTM F 2510 as applicable for flexible (HDPE, PP, FRP and CMP) pipe. Rigid (concrete) pipe to manhole connections do not have to comply with ASTM C 923 and may grouted instead.
- C. Water Lines
 - 1. Where smooth exterior pipes, i.e., steel, ductile iron, or PVC pipes are connected to manhole base or barrel, seal space between pipe and manhole wall with assembly consisting of rubber gasket or links mechanically compressed to form a watertight barrier. Assemblies: Press-Wedge, Res-Seal, Thunderline Link-Seal, Advance Products & Systems InnerLynx, or approved equal. See Drawings for placement of assembly in manhole sections.
 - 2. When connecting concrete or cement mortar coated steel pipes, or as option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of a stainless steel power sleeve, stainless steel -up clamp and a rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.
- 2.8 SEALANT MATERIALS
 - A. Approved products in accordance with Section 01630 - Product Substitution Procedures.
 - B. Sealing material between precast concrete adjustment ring and manhole, between each adjustment ring, and between adjustment ring and manhole cover frame shall be a

hydrophilic elastic sealant, which adheres to both concrete and metal, or approved equal.

- C. Provide approved external sealing material from Canusa Wrapid Seal manhole encapsulation system, or approved equal.
- D. Provide Butyl Sealant: Provide Press-Seal EZ Stick, or equal, for HDPE rings.

2.9 CORROSION RESISTANT MANHOLE MATERIALS

- A. Where corrosion-resistant manholes are indicated on Drawings, refer to City of Houston's Approved Products List for liner and/or coating materials.

2.10 BACKFILL MATERIALS

- A. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

2.11 NON-SHRINK GROUT

- A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only addition of water.
- B. Meet requirements of ASTM C 1107 and have minimum 28-day compressive strength of 7,000 psi.

2.12 VENT PIPES

- A. Provide external vent pipes for manholes where indicated on Drawings.
- B. Buried Vent Pipes: Provide 3-inch or 4-inch PVC DWV pipe conforming to ASTM D2665. Alternatively, provide FRP pipe as specified for vent outlet assembly.
- C. Vent Outlet Assembly: Provide vent outlet assembly as shown on Drawings, constructed of following specified materials:
 - 1. FRP Pipe: Provide filament wound FRP conforming to ASTM D 2996 or centrifugally cast FRP conforming to ASTM D 2997. Seal cut ends in accordance with manufacturer's recommendations.
 - 2. Joints and Fittings: Provide epoxy bodied fittings and join pipe to fittings with epoxy adhesive
 - 3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on Drawings. Meet bolt pattern and dimensions for ASME B 16.125- pound flanges. Flange bolts shall be Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B.

4. Coating: Provide approved 2-component, aliphatic polyurethane coating using primer or tie coat recommended by manufacturer. Provide two or more coats to yield dry film thickness of at least 3 mils. Color shall be selected by the Engineer from manufacturer's standard colors.

2.13 PROHIBITED MATERIALS

- A. Do not use brick masonry for construction of manholes, including adjustment of manholes to grade. Use only specified materials listed above.

2.14 MANHOLE LADDER FOR WATERLINE MANHOLES

- A. Provide ladders for manholes in accordance with requirements noted in details on the Drawings.
- B. Refer to Drawings for ladder material.
- C. Refer to Section 05510 – Metal Fabrications or Section 06610 – FRP Fabrications for ladder material and installation requirements.
- D. Provide ladder safety or personal fall-arrest system for ladders that extend 24 feet or greater. Ladder safety system shall be SAF-T-CLIMB as manufactured by Honeywell Miller, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that lines and grades are correct.
- B. Determine if subgrade, when scarified and re-compacted, can be compacted to 95 percent of maximum Standard Proctor Density, at +3 percent optimum moisture content according to ASTM D 698 prior to placement of foundation material and base section. If it does not meet the moisture-density requirement, condition the subgrade until the required moisture-density requirement is met or treat as an unstable subgrade.
- C. Do not build manholes in ditches, swales, or drainage paths unless approved by the Engineer.

3.2 PLACEMENT

- A. Install precast manholes to conform to locations and dimensions shown on Drawings.
- B. Place sanitary and storm manholes at points of change in alignment, grade, size, pipe intersections, and end of sewer unless otherwise shown on Drawings.

3.3 MANHOLE BASE SECTIONS AND FOUNDATIONS

- A. Place precast base on 12-inch thick (minimum) foundation of cement stabilized sand. Compact cement-sand in accordance with requirements of Section 02321 - Cement Stabilized Sand. For Manholes over large diameter waterlines. See Paragraph 3.3 C.
- B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify the Engineer for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24- inch-thick layer of cement stabilized sand as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.
- C. For manholes located over large diameter water lines, place precast base on a foundation of cement stabilized sand extending from bottom of manhole to bottom of trench. Manhole base is to be a minimum of 12-inches above water line.

3.4 PRECAST MANHOLE SECTIONS

- A. Install sections, joints, and gaskets in accordance with ASTM C 1821 and the manufacturer's printed recommendations.
- B. Install precast adjustment rings above tops of cones or flat-top sections as required to adjust finished elevation and to support manhole frame.
- C. Seal any lifting holes with non-shrink grout.
- D. Where PVC liners are required, seal joints between sections in accordance with manufacturer's recommendations.
- E. Place at least two precast concrete grade rings with thickness of 12 inches or less, under casting.

3.5 PIPE CONNECTIONS AT MANHOLES

- A. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions.
 - 1. Where smooth exterior pipes, i.e. steel, ductile iron or PVC pipes are connected to manhole base or barrel, space between pipe and manhole wall shall be sealed with an assembly consisting of rubber gaskets or links mechanically compressed to form watertight. Assemblies: "Press-Wedge," "Res-Seal," "Thunderline Link-Seals," Advance Products & Systems InnerLynx, or approved equal. See Drawings for placement of assembly in manhole sections.

2. When connecting concrete or cement mortar coated steel pipes, or as an option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of stainless steel power sleeve, stainless steel take-up clamp and rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.
- B. When making a rigid (concrete) pipe connection to a concrete manhole the pipe is to be set in flexible joint sealant conforming to ASTM C 990. Grout pipe penetration in place on both inside and outside of manhole.
- C. Install approved resilient connectors at each flexible (HDPE, PP, FRP or CMP) pipe connection as per ASTM C- 923 and/or ASTM F 2510 to a concrete manhole.
- D. Ensure no concrete, cement stabilized sand, fill, or other rigid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on either interior or exterior of manhole. If necessary, fill space with compressible material to ensure full flexibility provided by resilient connector.
- E. Where new manhole is constructed on existing sewer, rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe springline using an adhesive recommended and supplied by waterstop manufacturer.
- F. Test connection for watertight seal before backfilling.

3.6 INVERTS FOR SANITARY SEWERS

- A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:
 1. Slope of invert bench: 1 inch per foot minimum; 1-1/2 inches per foot maximum
 2. Depth of bench to invert shall be at least equal to the largest pipe diameter.
 3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Drawings.
- B. Form invert channels with concrete if not integral with manhole base section. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.7 DROP CONNECTIONS FOR SANITARY SEWERS

- A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4 inches outside bells.
- B. Install drop connection when sewer line enters manhole higher than 24 inches above invert of manhole.

3.8 INVERTS FOR STORM SEWERS

- A. When precast, square or rectangular structures are used for sewer manholes, construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe- manhole connections. Conform to following criteria:
 - 1. Slope of invert bench: 1 inch per foot minimum; 1-1/2 inches per foot maximum.
 - 2. Depth of bench to invert: one half of largest pipe diameter.
 - 3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on drawings.
- B. Form invert channels with concrete, after all connections have been made
 - 1. Use 5 sack premix (bag) concrete or Class A concrete for inverts, with minimum compressive strength of 4,000 psi.

3.9 STUBS FOR FUTURE CONNECTIONS

- A. In manholes, where future connections are indicated on Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.10 MANHOLE FRAME AND ADJUSTMENT RINGS

- A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces joined with non-shrink grout. Set cast iron frame on adjustment ring in bed of approved sealant material. Install sealant bed consisting of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.
- B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame and adjustment rings and precast section.
- C. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. In unpaved areas, encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.11 BACKFILL

- A. Place and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities.
- B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to springline of pipe with Class B concrete or flowable fill.
- C. In unpaved areas, provide positive drainage away from manhole frame to natural grade. Provide minimum of 4 inches of topsoil conforming to requirements of Section 02911 Topsoil. Seed in accordance with Section 02921 - Hydromulch Seeding. When shown on Drawings, sod disturbed areas in accordance with Section 02922 - Sodding.

3.12 FIELD QUALITY CONTROL

- A. Conduct leakage testing of sanitary sewer manholes in accordance with requirements of Section 02533 - Acceptance Testing for Sanitary Sewers.

3.13 PROTECTION

- A. Protect manholes from damage until work has been accepted. Repair damage to manholes at no additional cost to the Authority.

END OF SECTION

Section 02085

VALVE BOXES, METER BOXES, AND METER VAULTS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Valve boxes for water service.
- B. Meter boxes for water service.
- C. Meter vaults for water service.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for valve boxes under this Section. Include payment in unit price for Section 02511 - Water Lines.
 - 2. No separate payment will be made for meter boxes under this Section. Include payment in unit price for Section 02512 - Water Tap and Service Line Installation.
 - 3. Payment for each size of meter vaults is on unit price basis per vault. Payment will be made for each vault installed, regardless of depth.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM A 48 - Standard Specification for Gray Iron Castings.
- B. ASTM D 256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- C. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
- D. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural

Load in the Edgewise Position.

- E. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- F. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturers' product data for following items for approval:
 - 1. Each type of valve box and lid.
 - 2. Each type of meter box and cover.
 - 3. Each type of meter vault frame and cover.
- C. Submit design calculations and shop drawings for precast vault elements, sealed by an Engineer registered in State of Texas.
- D. Submit shop drawings for cast-in-place meter vaults for approval if proposed construction varies from Drawings.
- E. Submit manufacturer's certification that plastic meter boxes meet requirements of Paragraph 2.5, Plastic Meter Boxes.

PART 2 PRODUCTS

2.1 VALVE BOXES

- A. Provide approved Type A, cast-iron/ductile-iron, slide-type, valve boxes. Design of valve box shall minimize stresses on valve imposed by loads on box lid.
- B. Cast letter "W" into lid, 1/2 inch in height and raised 3/32 inch, for valves serving potable water lines.
- C. Unless otherwise specified, uncoated cast iron.
- D. Riser Pipe.
 - 1. Provide 6-inch PVC, DR 18, riser pipes in accordance with Section 02506 – Polyvinyl Chloride Pipe or

2. 6-inch ductile-iron, thickness Class 51 riser pipes in accordance with Section 02501 – Ductile Iron Pipe and Fittings.
3. Provide single section of pipe.

E. Concrete for valve box placement:

1. For locations in new concrete pavement, provide strength and mix design of new pavement.
2. For other locations, provide concrete for sidewalks conforming to requirements of Section 02751 - Concrete Paving.

2.2 METER BOXES

A. Provide meter boxes for 5/8-inch through 1-inch meters of the following materials:

1. Non-traffic bearing locations: Cast iron, concrete or plastic.
2. Traffic bearing locations: Cast iron.

B. Provide meter boxes for 1 1/2-inch and 2-inch meters of cast iron.

C. Provide meter box with reading lid. Provide lids with spring-type latching devices. Lids shall contain sufficient metal that meter box can be easily located with metal detector. Cast words "WEST HARRIS COUNTY REGIONAL WATER AUTHORITY" and "WATER METER" into lid with letters of 1/2-inch height and raised 3/32 inch.

D. Meter box dimensions shall conform to the following approximate dimensions:

1. Length: At top – 15 1/2 inches; at bottom 20 inches
2. Width: At top – 12 1/2 inches; at bottom 14 3/4 inches
3. Height: 12 inches

E. Extensions: Meter box extensions 3 inches and 6 inches in height shall be available from manufacturer as standard item.

2.3 CAST-IRON METER BOXES

A. Cast-Iron Boxes: Clean and free from sand blow-holes or other defects conforming to requirements of ASTM A 48, Class 30B. Bearing surfaces shall be machined so that covers seat evenly in frames.

- B. Boxes and lids shall have dipped, coal-tar-pitch, varnish finish.
- C. Provide lock-type meter boxes when required by Drawings. Lock mechanisms shall work with ease.

2.4 CONCRETE METER BOXES

- A. Concrete Meter Boxes: Made of Class A concrete, with minimum 4000 psi compressive strength, conforming to requirements of Section 03315 - Concrete for Utility Construction. Construct to dimensions shown on Drawings.
- B. Castings: Free from fractures, large or deep cracks, blisters or surface roughness or any other defects that may affect serviceability.

2.5 PLASTIC METER BOXES

- A. Plastic Meter Boxes: Made of high density polyethylene conforming to the following ASTM standards:

ASTM	REQUIREMENT
D 256	Impact Strength = 1.9 ft.-lb./inch (Izod, Notched)
D 256	Impact Strength = 6.4 ft.-lb./inch (Izod, Un-Notched)
D 638	Tensile Strength (2.0 min.) = 3400 psi
D 648	Deflection Temperature = 170 degrees F
D 2240	Shore D, Hardness, 55-65 Impact Strength, Falling Dart Method, 160 inch-lb.
D 790	Flexural Modulus = 90,000 psi

- B. Meter boxes shall meet the following test requirements:
 - 1. Static Load: Not less than 2500 pounds using 6-inch disc with direct compression exerted at center of top of meter box with solid plastic lid.
 - 2. Deflection: Not less than 1000 pounds load required to deflect top edge of meter box 1/8- inch.
- C. Meter box body, without lid, shall weigh approximately 7 pounds.

2.6 METER VAULTS

- A. Meter vaults may be constructed of precast concrete, cast-in-place concrete to the specified dimensions in the Drawings.
- B. Concrete for Meter Vaults: Class A concrete, conforming to requirements of Section 03315 - Concrete for Utility Construction with minimum compressive strength of 4000 psi at 28 days.
- C. Reinforcing steel for meter vaults: Conform to requirements of Section 03315 Concrete for Utility Construction.
- D. Grates and Covers: Conform to requirements of Section 02091 – Non Metallic Frames, Grates, Rings, and Covers.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Obtain approval from the Engineer or Resident Project Representative (RPR) for location of meter vault.
- B. Verify lines and grade are correct.
- C. Verify compacted subgrade will support loads imposed by vaults.

3.2 VALVE BOXES

- A. Install riser pipe with suitable length for depth of cover indicated on Drawings or to accommodate actual finish grade.
 - 1. Install with bell on top of valve
 - 2. Place riser pipe in plumb, vertical position
- B. Install valve box and riser piping plumbed in a vertical position. Provide 6-inches telescoping freeboard space between riser pipe top butt end, and interior contact flange of valve box, for vertical movement damping. End of pipe resting on valve shall be notched out sufficiently to provide a snug fit around the valve bonnet and to center valve inside of pipe.
- C. Set, align, and adjust valve box so that lid is level with final grade.
- D. Paint covers of new valve boxes in fluorescent orange when installed. After completion and

acceptance by Authority, repaint covers black.

3.3 METER BOXES

- A. Install cast iron or plastic boxes in accordance with manufacturer's instructions.
- B. Construct concrete meter boxes to dimensions shown on Drawings.
- C. Adjust top of meter boxes to conform to cover elevations specified in Paragraph 3.5, Frame and Cover for Meter Vaults.
- D. Do not locate under paved areas unless approved by the Engineer. Use approved traffic-type box with cast iron lid when meter must be located in paved areas.

3.4 METER VAULTS

- A. Construct concrete meter vaults to dimensions shown on Drawings. Do not cast in presence of water. Make bottom uniform. Verify lines and grades are correct and compacted subgrade will support loads imposed by vaults. Interior meter vault depth is not allowed to exceed more than 4 feet unless approved by the Engineer.
- B. Precast Meter Vaults:
 - 1. Install precast vaults in accordance with manufacturer's recommendations. Set level on a minimum 3-inch-thick bed of sand conforming to requirements of Section 02320 - Utility Backfill Materials.
 - 2. Seal lifting holes with cement-sand mortar or non-shrink grout.
- C. Meter Vault Floor Slab:
 - 1. Construct floor slabs of 6-inch-thick reinforced concrete. Slope floor 1/4 inch per foot toward sump. Make sump 12 inches in diameter, or 12 inches square, and 4 inches deep, unless other dimensions are required by Drawings. Install dowels at maximum of 18 inches, center-to-center for keying walls to floor slab.
 - 2. Precast floor slab elements may be used for precast vault construction
- D. Cast-in-Place Meter Vault Walls:
 - 1. Key walls to floor slab and form to dimensions shown on Drawings. Minimum wall thickness shall be 4 inches.
 - 2. Cast walls monolithically. One cold joint will be allowed when vault depth exceeds 12 feet.

3. Set frame for cover in concrete

3.5 FRAME AND COVER FOR METER VAULTS

- A. Set cast iron frame in a mortar bed and adjust elevation of cover as follows:
 1. In unpaved areas, set top of meter box or meter vault cover 2 to 3 inches above natural grade
 2. In paved areas, set top of meter box or meter vault cover flush with adjacent concrete but no higher than 1/2-inch

3.6 BACKFILL

- A. Provide bank run sand in accordance with Section 02320 - Utility Backfill Materials and backfill and compact in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. In unpaved areas, slope backfill around meter boxes and vaults to provide a uniform slope 1- to-5 slope from top to natural grade.
- C. In paved areas, slope concrete down from meter box or vault to meet adjacent paved area.

END OF SECTION

Section 02086

ADJUSTING MANHOLES, INLETS, AND VALVE BOXES TO GRADE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Adjusting elevation of manholes, inlets, and valve boxes to new grades.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for adjusting manhole frames and covers, inlets, valve boxes, and meter boxes to grade for new construction under this Section. Include payment in unit price for related item.
 - 2. Payment for adjusting existing manholes, frame and cover, inlets, valve boxes, and meter boxes to a new grade is on a unit price basis for each.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

PART 2 P R O D U C T S

2.1 CONCRETE MATERIALS

- A. Provide concrete, conforming to requirements of Section 03315 - Concrete for Utility Construction.
- B. Provide precast concrete manhole sections and adjustment rings conforming to requirements of Section 02082 - Precast Concrete Manholes.
- C. Provide mortar conforming to requirements of Section 04061 - Mortar.

2.2 CAST-IRON MATERIALS

- A. Provide cast-iron materials conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

2.3 PIPING MATERIALS

- A. For riser pipes and fittings, refer to Sections 02501 - Ductile-Iron Pipe and Fittings through 02528 - Polyethylene Encasement Wrap.

2.4 MASONRY MATERIALS FOR STORM SEWER MANHOLES AND INLETS

- A. Provide brick masonry units conforming to the requirements of Section 04210 - Brick Masonry for Utility Construction.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine existing structure, valve box, frame and cover or inlet box, frame and cover or inlet, piping and connections for damage or defects affecting adjustment to grade. Report damage or defects to Engineer.

3.2 ESTABLISHING GRADE

- A. Coordinate grade related items with existing grade and finished grade or paving, and relate to established bench mark or reference line.

3.3 ADJUSTING MANHOLES AND INLETS

- A. Rebuild adjustment portion of manhole or inlet by adding or removing Adjustments. Follow procedures for the type of structure being adjusted detailed in the following Sections:
 - 1. Section 02081 - Cast-In-Place Concrete Manholes
 - 2. Section 02082 - Precast Concrete Manholes
 - 3. Section 02083 - Fiberglass Manholes
 - 4. Section 02632 - Cast-In-Place Inlets, Headwalls and Wingwalls
 - 5. Section 02633 - Precast Concrete, Inlets, Headwalls and Wingwalls
- B. Salvage and reuse cast-iron frame and cover or grate.
- C. Protect or block off manhole or inlet bottom using wood forms shaped to fit so that no debris or soil falls to bottom during adjustment.
- D. Verify that manholes and inlets are free of visible leaks as result of reconstruction. Repair leaks in manner subject to the Engineer's approval.

3.4 ADJUSTING VALVE BOXES

- A. Salvage and reuse valve box and surrounding concrete block as approved by the Engineer. No separate pay.
- B. Remove and replace 6 inch ductile iron riser pipe with suitable length for depth of cover required to establish adjusted elevation to accommodate actual finish grade.
- C. Reinstall valve box and riser piping plumbed in vertical position. Provide minimum 6 inches telescoping freeboard space between riser pipe top butt end and interior contact flange of valve box for vertical movement damping.
- D. After valve box has been set, align, and adjust so that top lid is level with final grade.

3.5 BACKFILL AND GRADING

- A. Backfill area of excavation surrounding each adjusted manhole, inlet, and valve box and compact according to requirements of Section 02316 - Excavation and Backfill for Structures.
- B. Grade ground surface to drain away from each manhole and valve box. Place earth fill around manholes to level of upper rim of manhole frame. Place earth fill around valve box concrete slab.
- C. In unpaved areas, grade surface at uniform slope of 1 to 5 from manhole frame to natural grade. Provide minimum of 4 inches of topsoil conforming to requirements of Section 02911- Topsoil. Provide seeding in accordance with Section 02921 - Hydro-Mulch Seeding or if sodding in accordance with Section 02922 - Sodding.

END OF SECTION

Section 02090

FRAMES, GRATES, RINGS, AND COVERS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Iron castings for manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings, and extensions.
- B. Ring grates.
- C. Trench Drainage
- D. Tree Grates

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for frames, grates, rings, covers, and seals under this Section. Include payment in unit price for related item.
 - 2. Payment to rack over existing manhole is on a unit price basis for each manhole.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

AASHTO

- A. Standard Specifications for Highway Bridges
- B. AASHTO M 306 – Standard Specification for Drainage, Sewer, Utility, and Related Castings
- C. AASHTO M 105 – Standard Specification for Gray Iron Castings
- D. ASTM A 48 - Standard Specification for Gray Iron Castings
- E. ASTM A 536 – Standard Specification for Ductile Iron Castings

- F. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- G. AWS - D 1.4 – Structural Welding Code – Steel Reinforcing Bars

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions.
- C. Submit shop drawings for fabrication and installation of casting assemblies that are not included in drawings or details. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.

PART 2 PRODUCTS

2.1 CASTINGS

- A. All castings shall be made from gray cast iron conforming to the requirements of AASHTO M105 class 35b or ductile iron conforming to the requirements ASTM A 536 70-50-05.
- B. Castings intended for traffic service shall be clean castings capable of withstanding an application of 40,000 pound proof load as described in Section 5 of AASHTO M 306 (includes items such as frames, grates, rings, covers, trench drainage, etc.)
- C. Fabricate castings to conform to shapes, dimensions, and with wording or logos shown on Drawings.
- D. All castings shall be manufactured in accordance with the requirement of Section 4 of AASHTO M 306.
- E. Unless otherwise indicated, all gray iron castings shall be provided uncoated.
- F. Each individual casting shall include all markings as shown on the specification drawings and shall be identified by the producing foundry showing the following: Name of producing foundry; country of manufacturer preceded by the words "Made in," such as "Made in USA"; material designation, heat identification and cast date (MM/DD/YY), casting lettering as required by the purchaser. If a casting is melted and poured at one foundry and labeled with the name of another organization, manufacturer, or foundry the casting shall include the name of the producing foundry and the organization the casting is produced for. The name of the producing foundry and the organization the product is made for shall have lettering of equal size, be in close proximity to each other, and be easily identified from the

same side of the casting. The casting shall also include any additional markings as required in Section 9 of AASHTO M 306 and Section 17 of AASHTO M 105.

2.2 TESTING REQUIREMENTS

- A. Testing shall be performed in accordance with the following inspection criteria unless otherwise specified in the contract or purchase order. The manufacturer/supplier shall be responsible for carrying out all of the required tests and inspections. All testing shall be conducted in the United States using purchaser approved reliable facilities. The manufacturer/supplier shall maintain complete records of all such tests and inspections. All testing shall be paid for by the manufacturer/supplier.
- B. The manufacturer shall report and certify material information obtained from separately cast test bars. If there are more than three test bar failures in a calendar year the manufacturer shall report this to the purchaser and shall discontinue supplying product. In order to resume supplying product, documentation that a new Quality System is in place to ensure material compliance must be submitted to and accepted by the purchaser.

2.3 SPECIAL FRAMES AND COVERS

- A. Where indicated on Drawings, provide watertight manhole frames and covers with minimum of four bolts and gasket designed to seal cover to frame. Supply approved watertight manhole covers and frames.
- B. Where shown on Drawing, provide manhole frames and covers with 48-inch diameter clear opening, with inner cover for 22-inch diameter clear opening. Provide approved inner cover with pattern shown on Drawings.
- C. Where indicated on Drawings provide security enabled covers or grates, to be secured with the addition of Cam locks and lock lugs to inhibit opening and removal of cover or grate without proper authorized tool. Supply approved security feature Frames, Cover or Grates.

2.4 FABRICATED RING GRATES

- A. Fabricate ring grates from reinforcing steel conforming to ASTM A 615.
- B. Conform to welds connecting bars to AWS D 1.4.
- C. Fabricate ring grates in accordance with City of Houston standard detail, "Ring Grate for Open End of 18 Inch to 72 Inch RCP Stubs to Ditch".

2.5 ADJUSTMENT RINGS FOR ASPHALT OVERLAYS

- A. Use castings conforming Paragraph 2.1.
- B. One piece casting with dimensions to fit frame and cover.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install castings according to approved shop drawings, instructions in related specifications, and applicable directions from manufacturer's printed materials.
- B. Set castings accurately at required locations to proper alignment and elevation. Keep castings plumb, level, true, and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.
- C. Set in mortar in mouth of pipe bell.
- D. Install adjustment rings in existing frames with clean bearing surfaces that are free from rocking.

END OF SECTION

Section 02105

CHEMICAL SAMPLING AND ANALYSIS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Preparatory work related to site remediation and excavation in a Potentially Petroleum Contaminated Area (PPCA).
- B. Sampling and analysis of site material.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices
 - 1. Preparatory work is paid on a lump sum basis. Item includes hiring environmental consultants, preparing Environmental Health and Safety Plan, preparing Environmental Work Plan, training personnel, and obtaining permits and additional insurance.
 - 2. Underground Utility Construction in PPCA.
 - a. Underground utility construction and appurtenances in areas identified within PPCA limits is on a linear foot basis, each basis, or lump sum basis, as shown in Exhibit 1– Bid Form.
 - b. Payment includes compensation for labor, equipment, and supervision for mobilization, environmental monitoring and field screening, handling, sampling, and testing of contaminated soil and groundwater. Contaminated soil may be Category I or II. Contaminated groundwater will be that encountered during excavation for underground utilities and flowing at a rate not greater than 20 gallons per minute. Included in this pay item is incremental cost for upgraded piping, gaskets, and appurtenant materials.
 - c. Limits of measurement under this section are noted in Section 01110 - Summary of Work, or on Drawings as ‘Begin PPCA Excavation’ and ‘End PPCA Excavation’, or other areas shown on the Drawings.

- d. Payment will be made upon receipt of field test reports from approved analytical laboratory.
- 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCE STANDARDS

- A. ASTM D 5092 - Practice for Design and Installation of Groundwater Monitoring Wells.
- B. Code of Federal Regulation (CFR), Title 40, Section 261.24. - Protection of the Environment.
- C. CFR, Title 29, Section 1910.120. - Occupational Safety and Health Administration, Department of Labor.
- D. CFR, Title 29, Section 1926. - Occupational Safety and Health Administration, Department of Labor.
- E. CFR, Title 40, Section 261, Appendix II. - Protection of the Environment.
- F. Texas Administrative Code (TAC), Title 30, Chapter 335. - Industrial Solid Waste and Municipal Hazardous Waste.
- G. TAC, Title 30, Chapter 334. - Underground and Aboveground Storage Tanks.
- H. TAC, Title 30, Chapter 106.533. - Exemptions from Permitting, Subchapter X. Waste Processes and Remediation.
- I. TAC, Title 30, Chapter 350. – Texas Risk Reduction Program (TRRP).
- J. U.S. Environmental Protection Agency (EPA), (SW-846) Test Methods for Evaluating Solid Waste, Office of Solid Waste and Emergency Response, Washington, D.C. (P1388-239223, November 1986).

1.04 DEFINITIONS

- A. Petroleum: Crude oil, natural gas, natural gas liquids, liquefied natural gas, and synthetic gas usable for fuel, as well as distillates of crude oil including gasoline, kerosene, diesel oil, motor oil, waste oil, jet fuels, and fuel oil.

- B. Potentially Petroleum Contaminated Area (PPCA): An area within station-to-station locations identified in Section 01110 or on Drawings where petroleum contamination has been detected or where contamination is suspected in the soil or groundwater. PPCA also includes areas where contamination is suspected or encountered during utility installation outside areas identified on Drawings, and such contamination has been verified by Engineer.
- C. Category I Soil: Soil containing visual or physical evidence of contamination, as described in paragraph 3.01, and that is not Category II Soil.
- D. Category II Soil: Soil that contains petroleum contamination in excess of levels identified in paragraph 3.04, and is consistent with a classification as Special Waste- PST as defined by TCEQ in their interoffice memo dated 4/12/94, or soil that contains visible free product or is impacted with non-petroleum compounds detected above Risk Reduction Standard Number 2 levels as defined in Texas Administrative Code, Title 30, Chapter 335.
- E. Potentially Contaminated Groundwater: Water recovered in a groundwater control system located in PPCA or groundwater that contains visual or physical evidence of contamination, as described in paragraph 3.01, and such contamination has been verified by Engineer.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit an Environmental Work Plan within 30 days after issuance of Notice to Proceed.
 - 1. The Environmental Work Plan shall be prepared by a Corrective Action Project Manager licensed in Texas, who has completed 40-hours of Health and Safety Training and the required annual refresher training, and in the employment of a registered Corrective Action Specialist firm.
 - 2. The Environmental Work Plan shall include the following items. Include methods and procedures for assuring work, which will be conducted under conditions expected in the field, is safe. Compile and arrange in a format that can be reviewed by TCEQ.
 - a. Proposed sequence of construction through PPCA;
 - b. Procedures for screening soil in PPCA, identifying Category I or II Soil;

- c. Procedures for handling material from PPCA;
 - d. Proposed location of stockpile areas;
 - e. Proposed reuse of Category I Soil as trench backfill below depths of 30 inches;
 - f. Proposed methods for disposal or recycling of Category I or II Soil;
 - g. Proposed carriers of Category I or II Soil or potentially contaminated groundwater with verification each is properly licensed;
 - h. Proposed recycle/disposal sites for Category I or II Soil or potentially contaminated groundwater with verification that each is properly licensed;
 - i. Copy of permit required for discharge of potentially contaminated groundwater in sanitary sewer system, if to be disposed in sanitary sewer;
 - j. Name and qualifications of Corrective Action Project Manager and professional environmental consultants for health, environmental, and safety issues regarding operations within PPCA; and,
 - k. Proposed analytical laboratory with verification it is accredited by A2LA or other recognized association, or it is a participant in the EPA's Performance Evaluation Program.
3. Do not commence work in PPCA until Environmental Work Plan has been reviewed and receipt acknowledged by Engineer.
- D. As work proceeds, submit field screening, monitoring and analytical laboratory test results on a weekly basis for soil and on a daily basis for groundwater. Summarize test results in tables together with applicable regulatory criteria.
- E. Submit copies of correspondence, reports, permits and other documents provided to, or received from, regulatory agencies.

1.06 PERSONNEL REQUIREMENTS

- A. Provide trained personnel who have completed minimum health and safety programs specified by the Occupational Safety and Health Administration in 29 CFR 1910.120. Before beginning work at the site, each employee that will work in

PPCA is required to have completed 40 hours health and safety training and the required annual refresher training.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Do not use polyvinyl chloride or other plastic material, unless approved by Engineer.
- B. Water Lines less than 24-inch diameter
 - 1. Furnish ductile-iron pipe or steel pipe material within station-to-station locations identified as PPCA on Drawings.
 - 2. Provide restrained joints for ductile-iron pipe or welded joints for steel pipe.
 - 3. Provide pipe material conforming to Section 02501 – Ductile Iron Pipe and Fittings or Section 02502 - Steel Pipe and Fittings.
- C. Water Lines 24-inch diameter and greater
 - 1. Furnish ductile-iron pipe or steel pipe material within station-to-station locations identified as PPCA on Drawings.
 - 2. Provide restrained joints for ductile-iron pipe or welded joints for steel pipe.
 - 3. Provide pipe material conforming to Section 02501 – Ductile Iron Pipe and Fittings or Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
- D. Sanitary Sewer Pipe Material.
 - 1. Furnish ductile iron pipe, fiberglass reinforced pipe, or equivalent protective materials approved by Engineer.
 - 2. Provide restrained joints.
 - 3. Provide pipe material conforming to Section 02501 – Ductile Iron Pipe and Fittings or Section 02504 - Fiberglass Reinforced Pipe. Use pipe with a minimum pressure rating of 150 psi.
- D. Use Viton (FKM) type gaskets, or approved equal, for water lines and appurtenances requiring gaskets. Use Nitrile Rubber type gaskets, or approved equal, for sanitary and storm sewer pipes, precast concrete manhole joints, and appurtenances requiring gaskets.

PART 3 EXECUTION

3.01 POTENTIALLY PETROLEUM CONTAMINATED AREAS

- A. Conduct operations in PPCA in accordance with the accepted Environmental Work Plan and the Environmental Health and Safety Plan and to minimize the spread of contamination. In other areas which are either detected or suspected to be potentially petroleum contaminated areas, immediately notify Engineer and proceed with work in accordance with this Section, unless otherwise directed by Engineer.
- B. Immediately notify Engineer and TCEQ's Region 12 Field Office whenever Category I or II Soil or potentially contaminated groundwater are encountered.
 - 1. Provide location, depth, type (soil or groundwater), source (if known), and evidence of suspected contamination.
 - 2. Determine if Category I Soil or potentially contaminated groundwater is present by visual or physical evidence of contamination. Visual or physical evidence includes:
 - a. Petroleum or chemical odor.
 - b. Indication of levels of contamination by air monitoring devices employed as part of the Environmental Health and Safety Plan.
 - c. Soil or groundwater discoloration.
 - d. Material oozing/dripping into excavation.
 - e. Liquid or oily sheen floating on groundwater.
 - f. Buried containers or refuse.
 - g. Field screening 'head-space' results in excess of a 25 ppm reading on a photoionization detector (PID) or flame ionization detector (FID).
- C. Install piping and gasket materials and appurtenances in conformance with appropriate section, except as modified in this Section.

- D. Construct trench dams within a utility trench at each boundary of PPCA and laterals to minimize potential for contaminant transport within pipe bedding material. A trench dam shall consist of at least 24 inches of cement stabilized sand with 10 percent bentonite clay added, extending from 6 inches below bottom of trench to within 12 inches of limits of topsoil or pavement.

3.02 ENVIRONMENTAL MONITORING

- A. An environmental consultant shall monitor conditions in PPCA, as specified in the Environmental Health and Safety Plan. Maintain safe working conditions in accordance with OSHA requirements (29 CFR 1926).

3.03 SCREENING PPCA SOILS

- A. An environmental consultant shall perform field screening of soil removed from excavation or tunneling in PPCA.
- B. Screening Procedures.
 - 1. Place samples in a sealed plastic bag and place in a warm location for 15 minutes prior to screening.
 - 2. Properly calibrate the PID/FID using a calibration gas. For PID use 100 ppm isobutylene and for FID use 100 ppm methane.
 - 3. Open bag just enough to insert instrument probe and take maximum headspace reading.
 - 4. Screen at least twice per hour while removing soils in open cut areas or shafts.
 - 5. During tunneling, screen once for each pipe length in pipe jacked tunnels or each advance of tunnel shield in primary lined tunnels. Screen at least once per shift when excavating.

3.04 SAMPLING AND TESTING

- A. Frequency.
 - 1. Sample soil in PPCA at a rate of not less than one composite sample for every 20 cubic yards of excavation or volume corresponding to every 50 linear feet of installed underground utility, whichever is more frequent.

2. Sample water from PPCA to be discharged to a sanitary sewer one week prior to initiation of discharge, and at a rate of one grab sample once per day during discharge to sanitary sewer.
- B. Analyze soil samples for parameters listed in Section 02120 – Off-Site Transportation and Disposal, Table 02120-1, Soil Criteria - Petroleum Only, and in accordance with SW-846. Handle as a Category II Soil if analytical results indicate any one, or more, parameters exceed allowable Maximum Concentration listed in Table 02120-1. If benzene concentration from composite sample is greater than 5 milligrams per kilogram (mg/kg) or lead concentration is greater than 30 mg/kg, perform Toxicity Characteristic Leaching Procedure (TCLP) analysis of appropriate compound for that sample to determine if a more stringent disposal classification is warranted. If contaminants other than petroleum are suspected, immediately notify Engineer who will determine the list of parameters to be analyzed. If such are encountered, compensation will be made under the Allowance for PPCA Handling. Use a 4-part representative composite sample for analysis of parameters, except when inconsistent with SW-846.
 - C. Analyze groundwater samples for discharge to sanitary sewers. Analyze samples for BTEX by EPA Method 602, 8020, or 8021; TPH by EPA Method 418.1 or Method TX 1005; and Lower Explosive Limit (LEL) in accordance with EPA Method 1010.
 - D. Conduct analyses by proposed analytical testing laboratory listed in Environmental Work Plan.

3.05 AIR MONITORING REQUIREMENTS

- A. Ensure health and safety of workers at the construction site. Maintain air quality within the construction zone to conform to exposure limits specified in Code of Federal Regulations (CFR) Title 29, Section 1910.120 enforceable by OSHA.
- B. Provide adequate shoring and sufficient escape ladders in accordance with applicable trench safety regulatory requirements.
- C. In the trench, continuously operate a combustible gas indicator (CGI) with LEL/O₂ meter to monitor vapor and oxygen levels. Properly calibrate CGI and provide an alarm that sounds if greater than or equal to 20 percent Lower Explosive Limit (LEL), less than or equal to 19.5 percent oxygen, or greater than or equal to 25 percent oxygen is reached. Record monitoring data from CGI every 15 minutes to ensure safe work conditions.
- D. Take appropriate measures during construction to keep LEL levels below 20 percent in the trench. If vapor concentrations exceed 20 percent of LEL stop

construction work, turn off equipment, and have workers immediately vacate the PPCA in an upwind direction.

- E. Take readings with PID/FID 50 feet downwind of area during excavation or work in contaminated excavation areas and until one hour after cessation of such work. Take readings within breathing zone at approximately 4 feet above ground level. Record readings, date, time, initials of person taking reading, PID/FID serial number and last calibration date of PID/FID in bound field book.

END OF SECTION

Section 02120

OFF-SITE TRANSPORTATION AND DISPOSAL

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Off-site disposal of non-hazardous and hazardous solid, liquid and resinous waste.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. Payment for transportation and disposal of Class II Soil at approved facility is on a cubic yard basis.
- 2. Payment for transportation and disposal of Class I Soil at approved facility is on a cubic yard basis.
- 3. No separate payment will be made for soil reused as backfill material.
- 4. Payment for transportation and disposal of contaminated groundwater at approved facility is on a per gallon basis.
- 5. No separate payment for groundwater discharged into a sanitary sewer.
- 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

- A. CFR, Title 29, Section 1910.120.- Occupational Safety and Health Administration, Department of Labor.
- B. Texas Administrative Code (TAC), Title 30, Chapter 335.- Industrial Solid Waste and Municipal Hazardous Waste.
- C. TAC, Title 30, Chapter 334.- Underground and Aboveground Storage Tanks.

- D. TAC, Title 30, Chapter 106.533.- Exemptions from Permitting, Subchapter X, Waste Processes and Remediation.
- E. U.S. Environmental Protection Agency (EPA), (SW-846) Test Methods for Evaluating Solid Waste, Office of Solid Waste and Emergency Response, Washington, D.C. (P1388- 239223, November 1986).

PART 2 P R O D U C T S (Not Used)

PART 3 E X E C U T I O N

3.01 HANDLING CATEGORY I AND II SOILS

- A. Do not place Category II Soil back into excavation. Properly dispose of Category II Soil at the facility listed in Environmental Work Plan. Category I Soil consistent with classification as Class II PST Waste as defined by Texas Commission on Environmental Quality (TCEQ) in their interoffice memo dated 4/12/94, and not Category II Soil (as demonstrated through laboratory testing) can be reused as backfill material, provided;
 - 1. Soil is reused in the same area from which it originated at depths greater than 30 inches below top of pavement, finished grade or ditch flowline, whichever is lower.
 - 2. Soil has suitable engineering properties for backfill material as specified in Section 02320 - Utility Backfill Material.
 - 3. Does not have indications of impact by contaminants other than petroleum.
- B. Do not spread Category I or II Soil on ground surface.
- C. Place Category I or II Soil in covered roll-off box with a minimum 20-mil plastic liner or in a stockpile at temporary storage area, pending receipt of analytical results and receipt of authorization from TCEQ and the disposal site for final disposal; or, in trucks for transport directly to the disposal facility.
 - 1. Do not commingle Category I or II Soil from different locations or with different sources.
 - 2. Temporary storage area to meet following criteria:
 - a. Within 2 miles of project site, to allow access by Authority

- personnel, unless otherwise approved by Engineer.
- b. Outside the 100-year floodplain.
- c. Outside of, and not adjacent to, an area known or suspected to be a wetland.
- d. Acceptable to Engineer.
- 3. Secure using temporary fencing or other means of controlling access.
- 4. Place stockpiled soils on an impervious membrane. Surround with a berm to prevent migration of soils or moisture either into or out of the stockpile, other than evaporation.
- 5. Protect and cover the stockpile with minimum 20-mil plastic or other approved waterproof membrane covering. Replace damaged covers.
- 6. Do not place soil over monitoring wells or piezometers, utility line manholes, or any other potential route for water to migrate to subsurface.
- 7. Handle runoff from the temporary storage area in accordance with paragraph 3.02, Handling Water.
- 8. Do not stockpile soil for greater than 30 days.
- 9. Remove remaining material, including excavated soil from construction site, from temporary storage area prior to completion of Work.
- D. Remove, handle, transport, stockpile, and dispose of Category II Soil under direction of Corrective Action Project Manager. Dispose waste classified (i.e., meets characteristics or other definitions of) a hazardous waste consistent with Resource Conservation and Recovery Act (RCRA) and 30 TAC Chapter 335.
- E. Transport Category I or II Soil in accordance with Department of Transportation (DOT) and TCEQ rules and regulations.
- F. Dispose Category I Soil, not reused as backfill, under direction of Corrective Action Project Manager, at a properly licensed facility with prior approval of Project Manager.
- G. Obtain signed manifests from the receiving facility and provide originals to Project Manager.
- H. Decontaminate large equipment to prevent cross-contamination with clean

material. Steam clean or pressure wash dump trucks, bulldozers, backhoes, and other large equipment prior to use in uncontaminated areas after being used in PPCA.

3.02 HANDLING WATER

- A. Prior to discharging petroleum contaminated groundwater, obtain an Industrial Wastewater Discharge Permit from the City of Houston for disposal directly to a sanitary sewer which discharges to a City-owned wastewater treatment plant.
- B. Procedures.
 - 1. Provide equipment sized to handle flows anticipated by dewatering operations.
 - 2. Include commercially available oil/water separator unit as part of the treatment system for dewatering operation discharging to sanitary sewer.
 - 3. Do not exceed limits listed in Table 02120-2, Potentially Contaminated Groundwater Discharge Limits for groundwater discharged to the sanitary sewer. Provide additional treatment systems as needed prior to discharge to sanitary sewers where groundwater contamination levels exceed those noted in Table 02120-2. Approval by Engineer shall be obtained for proposed treatment system prior to initiation of treatment and discharge.
 - 4. Comply with all applicable requirements of 30 TAC, Chapter 106.533, including submitting a PI-7 form to the TCEQ for a standard exemption of oil/water separator unit, and any additional treatment systems. Submit copy of PI-7 form to Engineer.
 - 5. Do not discharge treated water into sanitary sewer if water level is within one foot of the top of sanitary sewer manhole or would cause an overflow situation.
 - 6. Recover free product collected in treatment equipment. Recycle for beneficial reuse or dispose of recovered contaminants in a manner acceptable to Engineer and TCEQ.
 - 7. Transport potentially contaminated groundwater and free product in accordance with DOT and TCEQ rules and regulations for flammable products. Use DOT- licensed carrier for transport.
 - 8. Obtain signed manifests for potentially contaminated groundwater and free product from the receiving facility and provide originals to Engineer.

9. Furnish laboratory reports to Engineer within one week of sample date.
- C. Install and operate groundwater control systems, as described in Section 01578 - Control of Groundwater. Design and operate groundwater control systems so water from PPCA is handled in a system separated and isolated from groundwater control systems outside PPCA.
- D. Handle, test, treat, and discharge potentially contaminated groundwater to the sanitary sewer in accordance with the City of Houston, Industrial Wastewater Discharge Permit requirements, or have water evacuated and hauled for off-site treatment and disposal at a TCEQ-permitted facility. Perform discharge under direction of Corrective Action Project Manager.

3.03 AIR MONITORING REQUIREMENTS

- A. Ensure health and safety of workers at the construction site. Maintain air quality within the construction zone to conform to exposure limits specified in Code of Federal Regulations (CFR) Title 29, Section 1910.120 enforceable by OSHA.
- B. Provide adequate shoring and sufficient escape ladders in accordance with applicable trench safety regulatory requirements.
- C. In the trench, continuously operate a combustible gas indicator (CGI) with LEL/O₂ meter to monitor vapor and oxygen levels. Properly calibrate CGI and provide an alarm that sounds if greater than or equal to 20 percent Lower Explosive Limit (LEL), less than or equal to 19.5 percent oxygen, or greater than or equal to 25 percent oxygen is reached. Record monitoring data from CGI every 15 minutes to ensure safe work conditions.
- D. Take appropriate measures during construction to keep LEL levels below 20 percent in the trench. If vapor concentrations exceed 20 percent of LEL stop construction work, turn off equipment, and have workers immediately vacate the PPCA in an upwind direction.
- E. Take readings with PID/FID 50 feet downwind of area during excavation or work in contaminated excavation areas and until one hour after cessation of such work. Take readings within breathing zone at approximately 4 feet above ground level. Record readings, date, time, initials of person taking reading, PID/FID serial number and last calibration date of PID/FID in bound field book.

3.04 DISPOSAL OF MATERIAL

- A. Non-categorized Material. Dispose of excess or unsuitable excavated materials,

not Category I or II Soil, off-site in accordance with Section 01576 - Waste Material Disposal.

- B. Category I or II Soil. Dispose of excess or unsuitable excavated materials off-site at a state registered Treatment, Storage, or Disposal (TSD) facility. Obtain signed manifests from the receiving facility and provide originals to Engineer.

TABLE 02120-1
SOIL CRITERIA - PETROLEUM ONLY

Contaminant	Maximum ^a Concentration (mg/kg)	Method
TPH	1500	EPA 418.1/TX 1005
Total BTEX	150	EPA 8020/8021
Total Lead	30	EPA 6000/6010/7000

Notes: ^a If any parameters exceed the maximum concentrations, then the soil shall be considered Category II Soil and a Special Waste-PST as defined by the TCEQ in their interoffice memo dated 4/12/94.

Definitions: BTEX - benzene, toluene, ethyl benzene, and total xylenes
 TPH - total petroleum hydrocarbons
 mg/kg - milligrams per kilogram
 mg/l - milligrams per liter

TABLE 02120-2
POTENTIALLY CONTAMINATED GROUNDWATER DISCHARGE LIMITS

Parameter	Discharge to Sanitary Sewer	
	Limit	Method
TPH (mg/l)	30.0	EPA 418.1/TX 1005
Total BTEX (mg/l)	1.0	EPA 602/8020/8021
Lower Explosive Limit (%)	10	EPA 1010

Notes: See definitions above.

END OF SECTION

SECTION 2136

WASTE MATERIAL HANDLING, TESTING AND DISPOSAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Handling, testing and disposal of hazardous and non-hazardous waste material.
- B. Material present inside of existing tanks to be repaired or demolished, i.e., silt, sludge and other residue deposits generated by normal water production usage of the tanks.
- C. Existing coatings removed from existing tanks.
- D. Spent abrasives used and debris generated in the execution of the work.
- E. All spent thinners, coating materials or other products brought on site for execution of work that require disposal as a hazardous or non-hazardous waste.
- F. Soil that may be contaminated due to the execution of the work.
- G. Petroleum soaked sand foundation material removed from demolished tanksites.

1.2 MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for handling, testing or disposal of non- hazardous or hazardous material, debris or material identified as contaminated material on the site prior to the bid date except as indicated in section 1.2 B and 1.2 C. The Contractor shall include the cost for this work in the Contract bid price for work of which this is a component part.
- B. Payment for hazardous waste material handling, removal, testing, transporting and disposal of material identified as hazardous after the bid date will be paid for at the unit price bid for "Hazardous Waste Handling, Removal, Transporting" if such an item is provided in the contract.
- C. Removal and disposal of potentially petroleum soaked sand foundation material will be measured per cubic yard which shall include testing, removing, storing, transporting and disposing of material and will be paid for at the unit price bid for "Removal and Disposal of Potentially Petroleum Soaked Sand". Basis of payment will be Class I Industrial Waste having a Total Petroleum Hydrocarbon (TPH) level greater than 1500 ppm.

1.3 REFERENCES

The following is a list of applicable requirements to this project. It is not intended to be a complete listing of all laws and regulations to which the Contractor must comply.

A. Environmental Protection Agency - Code of Federal Regulations

1. 40 CFR Part 261 - Identification and Testing of Hazardous Waste
2. 40 CFR 261, Appendix II EPA - Toxicity Characteristic Leaching Procedure
3. 40 CFR Part 262 - Standards Applicable to Generators of Hazardous Waste
4. 40 CFR Part 263 - Standards Applicable to Transporters of Hazardous Waste
5. 40 CFR Part 264 - Standards for Owner and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
6. 40 CFR Part 265 - Interim Status for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
7. 40 CFR 265, Subpart C EPA - Preparedness and Prevention
8. 40 CFR 265, Subpart D EPA - Contingency Plan and Emergency Procedures
9. 40 CFR 265.16 EPA - Personnel Training
10. 40 CFR Part 268 - Land Disposal Restrictions
11. 49 CFR Parts 173, 178 and 179: (USDOT/ Hazardous Materials, Shipping, Containers.)
12. 40 CFR Part 355 - Emergency Planning and Notification

B. EPA Methods

1. 3050 - Acid Digestion of Sediment, Sludge, and Soils
2. SW 846 - Test Methods for Evaluating Solid Waste - Physical/Chemical Methods

C. Texas Commission on Environmental Quality

1. TAC Title 30, Chapter 305 "Consolidated Permits"
2. TAC Title 30, Chapter 335 "Industrial Solid Waste and Municipal Hazardous

Waste"

3. TAC Title 30, Chapter 343 "Oil and Hazardous Substances"

D. TWC Technical Guidelines

1. Document #1, Waste Evaluation/Classification

E. NIOSH Methods

1. 7082 Lead

F. Society for Protective Coatings

1. SSPC 91-18 - Industrial Lead Paint Removal Handbook
2. Guide 6 - Guide for Containing Debris Generated During Paint Removal Operations
3. Guide 7 - Guide for the Disposal of Lead Contaminated Surface Preparation Debris

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 – Submittal Procedures.
- B. Submittals shall conform to appropriate codes for regulatory requirements.
- C. Obtain and submit disposal permits for proposed disposal sites, if required by local ordinances.

1.5 TESTING AND IDENTIFICATION

- A. The Owner is the Generator of the debris for permitting purposes, and will obtain the EPA Identification number, but the Contractor is responsible for assuring that all testing, handling, storage, transportation, and disposal requirements are properly implemented, including satisfactory training of job site personnel and the cleaning of all reusable items and equipment prior to removal from the site.
- B. Prior to the bid date, if testing has been performed by the Authority and if hazardous material has been identified in the debris material in an existing tank, the paint to be removed from an existing tank, the work site soil, or the foundation material, the material or test results will be indicated in section 01110 – Summary of Work. It is the responsibility of the Contractor to properly test and to determine if any wastes generated as a result of this project are hazardous in accordance with 40 CFR Part 261.

1.6 DEFINITIONS

(Note Definitions applicable to this section are also presented elsewhere.)

- A. Hazardous Waste (lead paint debris): Waste that is classified as hazardous due to its concentrations of regulated hazardous substances. Paint debris is classified as hazardous waste if, after testing by the Toxicity Characteristic Leaching Procedure (TCLP), the leachate contains any of the 8 metals or other substances in concentrations at or above limits established in 40 CFR 261.
- B. Lead Containing Dust and Debris: Dust and debris generated during the project which contains lead in any amount, including but not limited to pulverized paint, spent abrasive, filters (wet and dry), and containment materials upon which lead is still present.
- C. RCRA: Resource Conservation and Recovery Act. Federal law pertaining to hazardous waste management. EPA implementing regulations are contained in 40 CFR 240-280.
- D. TACB: Texas Air Control Board. Texas State Agency joined into the TCEQ and responsible for writing and enforcement of rules and regulations relating to air quality.
- E. TCEQ: Texas Commission on Environmental Quality. State of Texas Commission responsible for planning, oversight, monitoring and management of natural resources.
- F. TCLP: Toxicity Characteristic Leaching Procedure. Laboratory tests conducted on wastes that determine the amount of hazardous materials that leach out into a test solution. The test is intended to simulate the properties of water as it leaches through a solid waste landfill. TCLP testing is defined in 40 CFR 261, Appendix II.
- G. TWC: Texas Water Commission. Texas State Agency joined into the TCEQ and responsible for writing and enforcement of rules and regulations relating to water quality and solid waste programs.

PART 2 NOT USED

PART 3 EXECUTION

3.1 WASTE HANDLING AND STORAGE

- A. All chemicals to be brought on site by the contractor must be stored and used in a safe and proper manner in accordance with all applicable Federal, State and local laws and regulations as well as the manufacturer's recommendations. Material Safety Data Sheets (MSDSs) shall be maintained on-site for all hazardous chemicals used.

- B. Hazardous wastes are to be handled and stored according to the requirements of TAC 30 Chapter 335 "Industrial Solid Waste and Municipal Hazardous Waste" and 40CFR Part 262, with regard to on-site storage, and 40CFR Part 264 with regard to required notices, site security, personnel training, contingency planning and emergency procedures, recordkeeping and reporting, time of storage, amount of material stored, and use of proper containers. Hazardous waste will be stored in covered containers in accordance with the requirements of 40 CFR 262 and 49 CFR 172,178 and 179.
- C. The contractor shall provide proper, segregated storage for hazardous and non-hazardous materials to be used in the work area in order to ensure safe work conditions.
- D. All material, waste and debris from removal of lead containing coatings, including those products and materials employed for chemical paint stripping, shall be considered hazardous waste and handled accordingly, until such time that testing and analysis indicates otherwise.
 - 1. Sampling of materials for TCLP testing of initial containers of debris shall be completed prior to or during filling. Until the TCLP test results are received, the containers shall be labeled as lead-containing debris. Hazardous waste labels shall be applied after the test results are received, if the debris tests hazardous.
 - 2. Hazardous waste shall not be stored at the project site for more than 90 days. Non- hazardous wastes shall be removed at a minimum of once per month (30 days).
 - 3. Special attention shall be given to the time of storage, storage conditions, amount of material stored at any one time, use of proper containers, and personnel training.
- E. Hazardous waste shall be placed on pallets over protected ground, be located in a secure area enclosed by a fence with signs around the perimeter, and be shielded adequately to prevent dispersion of the waste by wind or water. Under no circumstances shall the waste be stored within a flood plain area. Any evidence of improper storage shall be cause for immediate shutdown of the project until corrective action is taken. The storage area shall be within a security fence with a locked gate.

3.2 ENVIRONMENTAL CONTAMINATION

The contractor shall not contaminate the air, soils or surface and ground waters with any hazardous waste. Spills, releases and discharges of hazardous or toxic materials which inadvertently occur shall be reported in accordance with 40 CFR 265 and TAC 30 Chapter 343.

- A. Contingency Plan and Training: The Contractor shall comply with TCEQ Title 30

Regulations and EPA 40 CFR 265, Subpart C in the event of a spill or release of waste, EPA 40 CFR 265 Subpart D, and TCEQ regulations.

- B. All personnel associated with the handling of hazardous waste shall complete a formal training program in accordance with 40 CFR 265.16 and TCEQ Title 30 Regulations. Training records of all employees must be maintained and kept on file.

3.3 WASTE CLASSIFICATION

A. Testing

1. All solid waste generated by the paint removal activities shall be tested in accordance with 40 CFR 261, Appendix II, Method 1311 Toxicity Characteristic Leaching Procedure (TCLP), to determine if it is hazardous.
2. In the case of wet methods of preparation, the use of chemical strippers, or containerized hygiene water, all liquids and sludge shall also be tested. When chemical strippers are used, the testing shall include pH to determine corrosivity. All waste water shall be tested for total lead.
3. Representative samples of the debris for each waste stream generated from the work on this project shall be collected. A minimum of four of the samples representative of each waste stream shall be analyzed to establish a waste is non-hazardous. Note that more than four initial samples of each waste stream shall be collected in order to obtain the four representative samples for analysis. Results from one test sample are sufficient to identify a waste as hazardous.
4. The collection of the initial representative samples of each waste stream and selection of the minimum of four for testing shall be accomplished using a random sampling technique and shall comply with the following: a minimum of one representative sample for each 55 gallons of waste, or a minimum of four representative samples for each gondola or roll-off box of waste. Samples shall be collected in accordance with SW-846, "Test Methods for Evaluating Solid Waste - Physical/ Chemical Methods".
5. Sampling and testing shall be performed by a certified laboratory acceptable to the Owner. The name, address, and qualifications of the laboratory shall be provided for approval. The Owner shall be provided with copies of the test results as soon as they are received by the Contractor.

B. Classification

1. Lead paint debris is classified as hazardous waste if, after testing by TCLP, the leachate contains any of the 8 metals or other hazardous substances in concentrations at or above limits established in 40 CFR 261:

Arsenic -	5.0 mg/L
Barium -	100.0 mg/L
Cadmium -	1.0 mg/L
Chromium -	5.0 mg/L
Lead -	5.0 mg/L
Mercury -	0.2 mg/L
Selenium -	1.0 mg/L
Silver -	5.0 mg/L

2. The above includes only the eight (8) characteristic metals listed by EPA among which are elements typically associated with paints. Other substances may be present which may cause debris to be classified as hazardous waste as defined in 40 CFR 261 (such as a pH ≤ 2.0 or ≥ 12.5 resulting in corrosivity), and must be taken into account.

3.4 DISPOSAL

- A. The contractor shall arrange to have wastes and debris transported from the site in accordance with all COH Ordinances and State and Federal Laws. If wastes and/or debris is determined to be hazardous, transporting to be in accordance with TAC 30 Chapter 335 -Industrial Solid Waste and Municipal Hazardous Waste, 40CFR Part 263 - Standards Applicable to Transporters of Hazardous Waste and the applicable sections of 49 CFR Parts 171 through 179.
- B. Manifest and Reporting: The Contractor shall comply with all of the manifesting, certification, and reporting requirements of EPA 40 CFR 262, 40 CFR 268, and Texas regulations, including certificates of final disposal for each shipment.
- C. Copies of all records and reports, test sample chain of custody forms, TCLP and other test results shall be provided to the Owner.
- D. The contractor shall dispose of wastes and debris at a licensed site acceptable to the Owner. Hazardous wastes and debris shall be disposed of in accordance with 40CFR Part 265 and 40CFR Part 268 Land Disposal Restrictions. Manifesting of hazardous wastes shall be in accordance with 40CFR Part 262, Subpart B.
- E. Waste water resulting from surface preparation, washing, personal hygiene or decontamination shall not be discharged without testing and through arrangement with the local Publicly Owned Treatment Works (POTW) or other approved means.

END OF SECTION

Section 02221

REMOVING EXISTING PAVEMENTS
AND STRUCTURES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Removing concrete paving, asphaltic concrete pavement, brick pavement and base courses.
- B. Removing concrete curbs, concrete curbs and gutters, sidewalks and driveways.
- C. Removing pipe culverts, sewers, and sewer leads.
- D. Removing waterlines and water services lines including asbestos cement pipe per OSHA guidelines.
- E. Removing existing inlets and manholes.
- F. Removing and disposing of pre-stressed concrete beams and drill shafts.
- G. Removing miscellaneous structures of concrete or masonry.
- H. Removing existing bridge.
- I. Removing existing wood and demolition debris.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for removing and disposing of asphaltic surfacing with or without base, regardless of thickness encountered, is on square yard basis measured between lips of gutters.
 - 2. Payment for removing and disposing of reinforced concrete pavement, with or without asphalt overlay, regardless of its thickness, is on square yard basis measured from back- to-back of curbs. Payment includes concrete pavement, esplanade curbs, curbs and gutters, and paving headers.
 - 3. Payment for removing and disposing of cement stabilized shell base course, with or without asphaltic surfacing, is on square yard basis.

4. Payment for removing and disposing of concrete sidewalks and driveways is on square yard basis.
5. Payment for removing asphaltic pavement surface by milling is on a square yard basis paid under item description Asphalt Surface Mill. This includes removal of existing surface to pavement base.
6. Payment for removing and disposing of miscellaneous concrete and masonry is on cubic yard basis of structure in place.
7. Payment for removing and disposing of pipe culverts, sewers, and sewer leads, is on linear foot basis for each diameter and each material type of pipe removed.
8. Payment for removing and disposing of waterlines and water service lines including asbestos cement pipe is on linear foot basis for each diameter pipe and each material type of pipe removed.
9. Payment for removing and disposing of existing inlets is on unit price basis for each inlet removed.
10. Payment for removing and disposing of prestressed concrete piles and drill shafts is on linear foot basis.
11. Payment for removing and disposing of existing bridge, including piles and abutments to minimum of 4 feet below ground level, is on a lump sum basis.
12. Payment for removing and disposing of existing manholes is on unit price basis for each manhole removed.
13. Payment for removing and disposing of miscellaneous wood and demolition debris is on cubic yard basis.
14. No payment for saw cutting of pavement, curbs, or curbs and gutters will be made under this section. Include cost of such work in unit prices for items listed in bid form requiring saw cutting.
15. No payment will be made for work outside maximum payment limits indicated on Drawings, or for pavements or structures removed for Contractor's convenience.
 - a. For utility installations: Match actual pavement replaced but no greater than maximum pavement replacement limits shown on Drawings. Limits of measurement will be as shown on Street Cut Pavement Replacement Rules.

16. Refer to Section 01270 - Measurement and Payment for unit price procedures

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for disposal of debris.
- B. Coordinate removal work with utility companies.
- C. For removal of asbestos containing materials, or material that could potentially contain asbestos, comply with applicable provisions of OSHA 29 CFR 1926.1101 – Asbestos, OSHA 29 CFR 1926.32 – General Safety and Health Provisions, and EPA 40 CFR 61 Subpart M – National Emission Standard for Asbestos.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.1 PREPARATION

- A. Obtain advance approval from Engineer for dimensions and limits of removal work.
- B. Identify known utilities below grade. Stake and flag locations.
- C. For removal of asbestos-containing materials, or materials that could potentially contain asbestos, comply with the following:
 - 1. Crew members must be trained in accordance with OSHA 29 CFR 1926.1101 – Asbestos.
 - 2. Conduct negative exposure assessment to demonstrate asbestos exposure below permissible exposure limit (PEL) in accordance with OSHA 29 CFR 1926.1101 – Asbestos and EPA 40 CFR 763 – Asbestos.
 - 3. If negative exposure assessment not conducted, or if results are above PEL, provide respiratory protection in accordance with Paragraph 3.02 of this Section.

3.2 PROTECTION

- A. Protect following from damage or displacement:

1. Adjacent public and private property.
 2. Trees, plants, and other landscape features designated to remain.
 3. Utilities designated to remain.
 4. Pavement and utility structures designated to remain.
 5. Bench marks, monuments, and existing structures designated to remain.
- B. When required, provide respiratory protection in accordance with OSHA 29 CFR 1910.134 – Respiratory Protection, and National Institute of Occupational Safety and Health (NIOSH).

3.3 REMOVALS

- A. Remove pavements and structures by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.
- B. Minimize amount of earth loaded during removal operations.
- C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of 2 inches.
- D. When street and driveway saw cut location is greater than one-half of pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by Engineer.
- E. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.
- F. Where existing end of pipe culvert or end of sewer is to remain, install 8-inch-thick masonry plug in pipe end prior to backfill in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.
- G. Labeling of Asbestos Cement (AC) Pipe:
1. Label leak-tight container with warning statement of hazardous asbestos content in accordance with OSHA 29 CFR 1926.1101 and as noted below.

2. Label waste material with following warning:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO
LUNGS DO NOT
BREATHE DUST AVOID
CREATING DUST

3. Neatly print labels in letters of sufficient size and contrast so label is easily visible and legible.

3.4 BACKFILL

- A. Backfill of removal areas shall be in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

3.5 DISPOSAL

- A. Inlet frames, grates, and plates; and manhole frames and covers, may remain Authority property. Disposal shall be in accordance with requirements of Section 01576 - Waste Material Disposal.
- B. Remove from site, debris resulting from work under this section in accordance with requirements of Section 01576 - Waste Material Disposal.
- C. For asbestos-containing materials:
 1. Comply with 40 CFR Part 61 and 30 TAC Sections 330.137(b) for Industrial Class 1 waste.
 2. Inspect load to ensure correct packaging and labeling.
 3. Line vehicles with two layers of 6-mil polyethylene sheeting.
 4. Remove asbestos-containing waste from site daily.

END OF SECTION

Section 02222

ABANDONMENT OF SEWERS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Abandonment in place of existing sewers, junction structures, manholes, and force mains.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for grout fill and abandonment of existing sewers, including boxes and elliptical shaped sewers, is on linear foot basis for each diameter of sewer being abandoned. Measurement will be along centerline of sewer from centerline to centerline of manholes.
2. Payment for grout fill and abandonment of sewer manholes or junction structure is by each manhole or junction structure abandoned in conformance with this Section.
3. Payment will be full compensation for all material, equipment, and labor required for complete abandonment grouting, including air venting, testing, temporary plugs, fill lines, excavations, and incidentals.
4. No separate payment will be made for plugging and abandoning sewer force mains. Include cost of such abandonment in related work. Refer to Section 01270 -Measurement and Payment for unit price procedures.
5. Acceptability of grout material is based on achieving average strength within range of 75 to 150 psi as defined in Paragraph 2.01B.1. Grout that is out of range after placement may be accepted with price adjustment of 1.0 percent price deduction for each psi average compressive strength below 75 psi and 0.5 percent price deduction for each psi average compressive strength above 150 psi, as applicable to material volume represented by test series. Shrinkage in grout material placements shall be remedied by Contractor according to Paragraph 3.04H without additional compensation.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract,

payment for Work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

- A. Abandonment. Sewer abandonment consists of demolition and removal of portion of manholes existing within specified depth of surface, and abandonment in place of sewer lines and manholes as specified in this Section.
- B. Flowable Fill. Flowable fill (abandonment grout) shall be controlled low-strength material consisting of fluid mixture of cement, fly ash, aggregate, water and with admixtures as necessary to provide workable properties. Placement of flowable fill may be by grouting techniques in sewer pipes or other restricted areas, or as mass placement by chutes or tremie methods in unrestricted locations with open access. Long-term hardened strength shall be within specified range.
- C. Ballast. Large aggregate either replaced with voids subsequently filled with flowable fill injected by grouting method; or in areas with open access, placed individually and sequentially at same time as flowable fill placement.
- D. Backgrouting. Secondary stage pressure grouting to ensure that voids have been filled within abandoned sewer. Backgrouting will only be required at critical locations indicated on Drawings or if there is evidence of incomplete flowable fill placements.

1.04 REFERENCE STANDARDS

- A. ASTM C 150 -Standard Specification for Portland Cement.
- B. ASTM C 494 -Standard Specification for Chemical Admixture for Concrete.
- C. ASTM C 618 -Standard Specification for Fly Ash and Raw or Calcinated Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete.
- D. ASTM C 937 -Standard Specification for Grout Fluidifier for Pre-placed Aggregate Concrete.
- E. ASTM C 940 -Standard Test Method for Expansion and Bleeding of Freshly Mixed Grout for Replaced Aggregate Concrete in the Laboratory.
- F. ASTM C 1017 -Standard Specification for Chemical Admixture for Use

in Producing Flowing Concrete.

- G. ASTM C 1107 -Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

- B. Flowable fill mix design report:

1. Flowable fill type and production method. Describe if fill will be mixed to final proportions and consistency in batch plant or if constituents will be added in transit mixer at placement location.
2. Use of ballast. Provide percentage of ballast of total placement and size limits for ballast if fill is intended to be used with ballast.
3. Aggregate gradation of fill. Aggregate gradation of mix (excluding ballast) shall be used as pilot curve for quality control during production.
4. Fill mix constituents and proportions including materials by weight and volume, and air content but excluding ballast. Give types and amounts of admixtures including air entrainment or air generating compounds.
5. Fill densities and viscosities, including wet density at point of placement.
6. Initial time of set.
7. Bleeding and shrinkage.
8. Compressive strength.

- C. Technical information for equipment and operational procedures including projected slurry injection rate, grout pressure, method of controlling grout pressure, bulkhead and vent design, and number of stages of grout application.

- D. Experience record for proposed crew, showing minimum of 100 cubic yards of flowable fill placed using proposed or similar equipment and methods.

- E. At least 60 days prior to commencing abandonment activities, submit

plan for abandonment, describing proposed grouting sequence, bypass pumping requirements and plugging, if any, and other information pertinent to completion of work.

- F. Technical information for manufactured pipe plugs for force mains noted in paragraph 2.03.B.
- G. Technical information on temporary plugs used for gravity sewers as noted in paragraph 3.03.C.

PART 2 P R O D U C T S

2.01 FLOWABLE FILL

- A. Design Mix Criteria. Provide design of one or more mixes to meet design criteria and conditions for placement. Present information required by Paragraph 1.05B in mix design report including following:
 - 1. Cement: ASTM C 150 Type I or II. Volume and weight per cubic yard of fill. Provide minimum cement content of 100 pounds per cubic yard.
 - 2. Fly ash: ASTM C 618 Class C or F. Volume and weight per cubic yard of fill. Provide minimum Fly ash content of 200 pounds per cubic yard.
 - 3. Potable water: Volume and weight per cubic yard of fill. Amount of water determined by mix design testing.
 - 4. Aggregate gradation: 100 percent passing 3/8-inch sieve and not more than 10 percent passing No. 200 sieve. Mix design report shall define pilot gradation based on following sieve sizes 3/8-inch, Nos. 4, 8, 16, 30, 50, 100, and 200. Do not deviate from pilot gradation by more than plus or minus 10 percentage points for any sieve for production material.
 - 5. Aggregate source material: Screened or crushed aggregate, pit or bank run fine gravels or sand, or crushed concrete. If crushed concrete is used, add at least 30 percent of natural aggregate to provide workability.
 - 6. Admixtures: Use admixtures meeting ASTM C 494 and ASTM C 1017 as needed to improve pumpability, to control time of set, and reduce bleeding.

7. Fluidifier: Use fluidifier meeting ASTM C 937 as necessary to hold solid constituents in suspension. Add shrinkage compensator if necessary.
8. Performance additive: Use flowable fill performance additive, such as Darafill or approved equal, to control fill properties.

B. Flowable Fill Requirements

1. Unconfined compressive strength: minimum 75 psi and maximum 150 psi at 56 days as determined based on an average of three tests for same placement. Present at least three acceptable strength tests for proposed mix design in mix design report.
2. Placement characteristics: self-leveling.
3. Shrinkage characteristics: non-shrink.
4. Water bleeding for fill to be placed by grouting method in sewers: not to exceed 2 percent according to ASTM C 940.
5. Minimum wet density: 90 pounds per cubic foot.

2.02 BALLAST

- A. Ballast Material: Natural rock or concrete pieces with minimum size equal to at least 10 times maximum aggregate size of flowable fill and maximum size of 24 inches. Maximum dimension shall not be more than 20 percent of minimum dimension of space to be filled.
- B. Ballast Composition: Free of regulated waste material.

2.03 PLUGS FOR FORCE MAINS

- A. Grout Plugs: Cement-based dry-pack grout conforming to ASTM C 1107, Grade B or C.
- B. Manufactured Plug: Commercially available plug or cap specifically designed and manufactured to be used with pipe being abandoned.

PART 3 EXECUTION

3.01 PREPARATION

- A. Have fill mix design reports and other submittals required by Paragraph 1.05 accepted by Engineer prior to start of placement. Notify Engineer at least 24

hours in advance of grouting with flowable fill.

- B. Select fill placement equipment and follow procedures with sufficient safety and care to avoid damage to existing underground utilities and structures. Operate equipment at pressure that will not distort or imperil portion of work, new or existing.
- C. Clean sewer lines and video with closed circuit television to identify connections, locate obstructions, and assess condition of pipe. Locate previously unidentified connections, which have not been redirected and reconnected as part of this project, and report them to Engineer. During placement of fill, compensate for irregularities in sewer pipe, such as obstructions, open joints, or broken pipe to ensure no voids remain unfilled.
- D. Perform demolition work prior to starting fill placement. Clean placement areas of sewers and manholes of debris that may hinder fill placement. Remove excessive amounts of sludge and other substances that may degrade performance of fill. Do not leave sludge or other debris in place if filling more than 2 percent of placement volume. Dispose of waste material in compliance with Section 01576 -Waste Material Disposal.
- E. Remove free water prior to starting fill placement.

3.02 EQUIPMENT

- A. Mix flowable fill in automated batch plant and deliver it to site in ready-mix trucks. Performance additives may be added at placement site if required by mix design.
- B. Use concrete or grout pumps capable of continuous delivery at planned placement rate.

3.03 DEMOLITION OF SEWER MANHOLES, PIPELINE STRUCTURES, AND FORCE MAINS PRIOR TO ABANDONMENT

- A. Remove manhole frames and covers and castings from other existing pipeline structures. Deliver castings to nearest Authority maintenance facility or as directed by the Engineer for future use. Alternatively, salvaged castings may be used upon approval by Engineer, for constructing new manholes on this project.
- B. Demolish and remove precast concrete adjustment rings and corner section, or brick and mortar corbel and chimney, or other pipeline structure, to minimum depth of 4 feet below finished grade. Structure may be removed to greater depth, but not deeper than 18 inches above crown of abandoned sewer.

- C. When adjacent sewer lines are not to be filled, place temporary plugs in each line connecting to manhole, in preparation for filling manhole.
- D. Excavate overburden from force mains to be abandoned at locations indicated on Drawings, conforming to Section 02317 -Excavation and Backfill for Utilities. Cut existing force main, when necessary, to provide an end surface perpendicular to axis of pipe and suitable for plug to be installed. Remove force main piping material remaining outside of segment to be abandoned.

3.04 INSTALLATION

- A. Abandon sewer lines by completely filling sewer line with flowable fill. Abandon manholes and other structures by filling with flowable fill, together with ballast as applicable, within depth of structures left in place.
- B. Place flowable fill to fill volume between manholes. Continuously place flowable fill from manhole to manhole with no intermediate pour points, but not exceeding 500 feet in length.
- C. Have filling operation performed by experienced crews with equipment to monitor density of flowable fill and to control pressure.
- D. Temporarily plug sewer lines which are to remain in operation during pouring/pumping to keep lines free of flowable fill.
- E. Pump flowable fill through bulkheads constructed for placement of two 2-inch PVC pipes or use other suitable construction methods to contain flowable fill in lines to be abandoned. These pipes will act as injection points or vents for placement of flowable fill.
- F. Place flowable fill under pressure flow conditions into properly vented open system until flowable fill emerges from vent pipes. Pump flowable fill with sufficient pressure to overcome friction and to fill sewer from downstream end, to discharge at upstream end.
- G. Inject flowable fill through replaced ballast using grouting equipment and series of grout pipes discharging at bottom of placement, allowing fill to rise through ballast effectively filling all voids. Alternatively, sequentially place individual pieces of ballast at same time as flowable fill is placed. Do not fill with ballast more than 50 percent of volume at any level, to prevent nesting and void formation.
- H. Remediate placement of flowable fill which does not fill voids in sewer, manhole or other structures, or where voids develop due to excessive shrinkage or bleeding of fill, by using pressure grouting either from inside

sewer or from surface. Pressure grout shall conform to Section 02431 - Tunnel Grout.

- I. Plug each end of force main being abandoned.
- J. Force main abandonment
 - 1. Clean inside surface of force main at least 12 inches from ends to achieve firm bond and seal grout plug or manufactured plug to pipe surface. Similarly, clean and prepare exterior pipe surface if manufactured cap is to be used.
 - 2. When using grout plug, place temporary plug or bulkhead approximately 12 inches inside pipe. Fill pipe end completely with dry-pack grout mixture.
 - 3. When using manufactured plug or cap, install fitting as recommended by manufacture's instructions, to form water tight seal.
- K. Backfill to surface, above pipe or structures left in place, with flowable fill in restricted areas, compacted bank run sand in unrestricted areas to be paved, or select fill in unrestricted areas outside of pavement. Place and compact backfill, other than flowable fill, in compliance with Section 02317 - Excavation and Backfill for Utilities.
- L. Collect and dispose of excess flowable fill material and other debris in accordance with Section 01576 -Waste Material Disposal.

3.05 FIELD QUALITY CONTROL

- A. Provide batch plant tickets for each truck delivery of flowable fill. Note on tickets addition of admixtures at site.
- B. Check flow characteristics and workability of fill as placement proceeds.
- C. Obtain at least three test cylinders for each placement area for determination of 56-day compressive strength and bleeding. Acceptance of placement will be based on average strength of three tests.
- D. Record volume of ballast together with flowable fill placement for same space to demonstrate that voids have been filled.

3.06 PROTECTION OF PERSONS AND PROPERTY

- A. Provide safe working conditions for employees throughout demolition and removal operations. Observe safety requirements for work below grade.

- B. Maintain safe access to adjacent property and buildings. Do not obstruct roadways, sidewalks or passageways adjacent to work.

END OF SECTION

Section 02233

CLEARING AND GRUBBING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Removing surface debris and rubbish.
- B. Clearing site of plant life and grass.
- C. Removing trees and shrubs.
- D. Removing root system of trees and shrubs.
- E. Fence removal.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for clearing and grubbing is on per acre basis.
 - 2. Payment for removal of standing fences indicated for removal is on per linear foot basis.
 - 3. Fence, abandoned and on the ground, is considered as debris and will not be measured for payment. No separate payment will be made for abandoned fence found on the ground.
 - 4. Payment for borrow material required to fill holes, when directed by Engineer is on cubic yard basis, measured in place.
 - 5. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for disposal of debris.
- B. Coordinate clearing work with utility companies.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.01 P R E P A R A T I O N

- A. Verify that existing plant life and features designated to remain are identified and tagged.
- B. Three wire barbed wire fences opened for access to the right-of-way shall be made up with a gap. Other fences opened for access to the right of-way shall be provided with a temporary gate and then restored after clearing and grubbing.

3.02 P R O T E C T I O N

- A. Protect following from damage or displacement:
 - Living tree of any species listed on the City of Houston street tree list that has a caliper of 20 inches or more, measured 54 inches above the ambient grade for trees having a diameter greater than eight inches, and is situated in the building setback (25') area along a local street or along a major thoroughfare.
- 1. Plants other than trees and landscape features designated to remain.
- 2. Utilities designated to remain.
- 3. Bench marks, boundary monuments, and existing structures designated to remain.

3.03 C L E A R I N G

- A. Remove stumps, main root ball, and root system to:
 - 1. Depth of 24 inches below finished subgrade elevation in area bounded by lines 2 feet behind back of curbs.
 - 2. Depth of 24 inches below finished surface of required cross section for other areas.
- B. Clear undergrowth and deadwood without disturbing subsoil.
- C. Remove vegetation from top soil scheduled for reuse.
- D. Clear vegetation and debris within the project limits from right-of-way line to right-of-way line. Clearing shall consist of removing all trees, brush, overhangs, logs, tires, appliances, trash, rubbish and other debris, including but not limited to; fences, rubbish, concrete, stones, bricks, tires, plastic debris, steel, pipes/piping, lumber/wood, tanks, drums, containers, refrigerators, dishwashers, washing machines, dryers,

bicycles, miscellaneous construction debris and any other undesirable and objectionable or deleterious materials, that exist within the limits of the project.

3.04 GRUBBING

- A. Grubbing shall be conducted to remove all stumps and roots greater than 2 inch diameter to a depth of 24 inches below the existing ground surface. All holes remaining after clearing and grubbing shall be backfilled with suitable on site material and compacted to 95 percent of Standard Proctor Density (ASTM Method D698) at a moisture content of between optimum and plus 3 percent of optimum as directed by the Engineer and the entire area bladed to prevent ponding of water and to provide drainage; except in areas to be immediately excavated, the Engineer may direct that the holes not be backfilled. On areas required for borrow sites and material sources, stumps, roots, etc., shall be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used in construction.

3.05 REMOVAL

- A. Remove debris, rubbish, and extracted plant material life from site in accordance with requirements of Section 01576 - Waste Material Disposal.
- B. Remove on-site fences. Materials generated from removal of fences become property of Contractor. Properly dispose of in accordance with applicable local, state and federal laws.
- C. Contractor shall not bury any refuse on the right-of-way property. The disposal site shall not be an environmentally sensitive area, "Water of the United States", wetland, or floodway. It is the responsibility of the contractor to contact the proper authorities to determine land use classification and to obtain any necessary permits. No burning shall be allowed.

END OF SECTION

Section 02260

TRENCH SAFETY SYSTEM

PART G E N E R A L

1.1 SECTION INCLUDES

- A. Trench safety system for the construction of trench excavations.
- B. Trench safety system for excavations which fall under provisions of State and Federal trench safety laws.
- C. This Standard Specification Section replaces previously published Section 01561-Trench Safety System.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Measurement for trench safety systems used on trench excavations is on a linear foot basis measured along the centerline of the trench, including manholes and other line structures.
 - 2. No payment will be made under this section for trench safety systems for structural excavations, tunnel shafts, auger pits, or excavation for trenchless installations, and also for any necessary non trenchless installations included in the aforementioned methods of construction unless included as a bid item in Exhibit 1 – Contractor’s Bid. Include payment for trench safety systems in applicable structural or utility installation sections.
 - 3. Refer to Section 01270 - Measurement and payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 DEFINITIONS

- A. A trench shall be defined as a narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.
- B. The trench safety system requirements will apply to larger open excavations if the erection

of structures or other installations limits the space between the excavation slope and these installation to dimensions equivalent of a trench as defined.

- C. Trench Safety Systems include but are not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.
- D. Trench Safety Program is the safety procedures governing the presence and activities of individuals working in and around trench excavations.

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit a safety program specifically for the construction of trench excavation. Design the trench safety program to be in accordance with OSHA 29CFR standards governing the presence and activities of individuals working in and around trench excavations.
- C. Construction and shop drawings containing deviations from OSHA standards or special designs shall be sealed by a licensed Engineer retained and paid by Contractor.
- D. Review of the safety program by the Design Professional of Record (DPOR) will only be in regard to compliance with this specification and will not constitute approval by the DPOR nor relieve Contractor of obligations under State and Federal trench safety laws.
- E. Submit certification that trench safety system will not be subjected to loads exceeding those which the system was designed to withstand according to the available construction and geotechnical information.

1.5 REGULATORY REQUIREMENTS

- A. Install and maintain trench safety systems in accordance with the detail specifications set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in the Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652.
- B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request to Contractors bidding on Authority projects. The Authority assumes no responsibility for the accuracy of the reproduction. The Contractor is responsible for obtaining a copy of this section of the Federal Register.

- C. Legislation that has been enacted by the Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into these specifications. Refer to Texas Health and Safety Code Ann., §756.021 (Vernon 1991).

1.6 INDEMNIFICATION

- A. Contractor shall indemnify and hold harmless the Authority, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgements or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this Contract.
- B. Contractor acknowledges and agrees that this indemnity provision provides indemnity for the Authority in case the Authority is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and the hiring of the Contractor.

PART P R O D U C T S - Not Used

PART E X E C U T I O N

3.1 INSTALLATION

- A. Install and maintain trench safety systems in accordance with provisions of OSHA 29CFR.
- B. Install specially designed trench safety systems in accordance with the Contractor's trench excavation safety program for the locations and conditions identified in the program.
- C. A competent person, as identified in the Contractor's Trench Safety Program, shall verify that trench boxes and other pre-manufactured systems are certified for the actual installation conditions.

3.2 INSPECTION

- A. Contractor, or Contractor's independently retained consultant, shall make daily inspections of the trench safety systems to ensure that the installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.
- B. If evidence of possible cave-ins or slides is apparent, Contractor shall immediately stop work in the trench and move personnel to safe locations until the necessary precautions have been taken by Contractor to safeguard personnel entering the trench.
- C. Maintain a permanent record of daily inspections.

3.3 FIELD QUALITY CONTROL

- A. Contractor shall verify specific applicability of the selected or specially designed trench safety systems to each field condition encountered on the project.

END OF SECTION

Section 02315

ROADWAY EXCAVATION

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Excavation and compaction of materials for roadways.
- B. Excavation and compaction of materials for roadside ditches.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for roadway excavation, with or without subgrade, is on cubic yard basis. Unless specified otherwise under the borrow (off-site) material or embankment fill work item, measurement for payment shall be based on the cut quantity shown on the drawing.
 - 2. No payment will be made for material excavated under the following conditions:
 - a. More than 2 feet outside of vertical planes behind back of curbs
 - b. For portion within limits of trench for utilities 24-inch and greater constructed by open-cut methods
 - c. As indicated otherwise on Drawings.
 - 3. Measurement for the bid item "Regrade Ditches" is on a linear foot basis. No separate payment will be made for reshaping and regrading roadway ditch shoulder slope and side slope adjacent to installed temporary pavement upon removal of temporary pavement.
 - 4. If specified, off-site borrow material including placement and compaction will be paid by final in-place quantity on cubic yard basis.
 - 5. If specified and shown on the drawing, embankment fill including placement and compaction will be paid by final in-place quantity on cubic yard basis.
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft³).
- B. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- C. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- D. ASTM D 3017 - Standard Test Method for Water content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Provide topsoil conforming to requirements of Section 02911 - Topsoil.
- B. Provide backfill which is excavated material, graded free of roots, lumps greater than 6 inches, rocks larger than 3 inches, organic material, and debris.
- C. Provide structural backfill which is select material meeting following requirements:
 - 1. Plasticity index: not less than 12 nor more than 20.
 - 2. Maximum liquid limit: 45

PART 3 E X E C U T I O N

3.1 PREPARATION

- A. Identify required lines, levels, and datum. Coordinate with Section 01725 - Field Surveying.
- B. Identify and flag surface and aerial utilities.

- C. Notify utility companies to remove or relocate utilities.
- D. Identify, stake, and flag known utility locations below grade. Make temporary or permanent relocation of underground pipes, ducts, or utilities where indicated on Drawings.
- E. Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.
- F. Obtain approval of top soil quality before excavating and stockpiling.

3.2 PROTECTION

- A. Protect following from damage or displacement:
 - 1. Trees, shrubs, lawns, existing structures, and other features outside of grading limits.
 - 2. Utilities either above or below grade, which are to remain.

3.3 TOPSOIL REMOVAL

- A. Strip off topsoil from area to be excavated to minimum depth of 6 inches, unless indicated otherwise on Drawings.
- B. Stockpile topsoil in designated location for reuse. Stockpile topsoil to depth not exceeding 8 feet. Cover to protect from erosion.

3.4 SOIL EXCAVATION

- A. Excavate to lines and grades shown on Drawings.
- B. Remove unsuitable material not meeting specifications. Backfill with embankment materials and compact to requirements of Section 02330 - Embankment.
- C. Record location and plug and fill inactive water and oil wells. Conform to Texas Department of Health, Texas Natural Resource Conservation Commission, and Texas Railroad Commission requirements. Notify Engineer prior to plugging wells.
- D. At intersections, grade back at minimum slope of one inch per foot. Produce smooth riding junction with intersecting street. Maintain proper drainage.
- E. When area is inadvertently over excavated, fill area in accordance with requirements of Section 02330 - Embankment at no additional cost to Authority.

- F. Remove material not qualified for use and excess soil not being reused from site in accordance with requirements of Section 01576 - Waste Material Disposal.

3.5 COMPACTION

- A. Maintain optimum moisture content of subgrade to attain required density.
- B. Compact to following minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on Drawings:
 - 1. Areas under future paving and shoulders: Minimum density of 95 percent of maximum dry density.
 - 2. Other areas: Minimum density of 90 percent of maximum dry density.

3.6 TOLERANCES

- A. Top of Compacted Surface: Plus or minus 1/2 inch in cross section, or in 16-foot length.

3.7 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Test and analysis of soil materials will be performed in accordance with ASTM D 4318, ASTM D 2216, and ASTM D 698.
- C. Compaction testing will be performed in accordance with ASTM D 698 or ASTM D 2922 and ASTM D 3017.
- D. A minimum of three tests will be taken for each 1000 linear feet per lane of roadway.
- E. When tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at no additional cost to Authority.

3.8 PROTECTION

Prevent erosion at all times. Maintain ditches and cut temporary swales to allow natural drainage in order to avoid damage to roadway. Do not allow water to pond.

- A. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.
- B. Maintain excavation and embankment areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density.

3.9 REGRADE DITCHES

- A. Work shall consist of excavating ditches, rectifying and/or altering existing ditches, placement of erosion control blanket, grading side slopes to line and grade as shown on Drawings or as directed by Engineer; removal and proper utilization or disposal of excavated materials to ensure proper drainage of project area.

END OF SECTION

Section 02316

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Excavation, backfilling, and compaction of backfill for structures.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for structural excavation and backfill under this Section. Include payment in unit price or lump sum for construction of structures.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 DEFINITIONS

- A. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable

soils after treatment with lime or cement shall be considered suitable, unless otherwise indicated.

- C. Select Material: Material as defined in Section 02320 - Utility Backfill Materials.
- D. Backfill: Material meeting specified quality requirements, placed and compacted under controlled conditions around structures.
- E. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.
- F. Foundation Base: For foundation base material, use crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.
- G. Foundation Subgrade: Foundation subgrade is surface of natural soil which has been excavated and prepared to support foundation base or foundation backfill, where needed.
- H. Ground Water Control Systems: Installations external to excavation such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.
- I. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from excavation. Remove rain water and surface water which accidentally enters excavation as part of excavation drainage.
- J. Excavation Drainage: Removal of surface and seepage water in excavation by sump pumping and using French drains surrounding foundation to intercept water.
- K. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below foundation as shown on Drawings, and backfilled with foundation backfill material.
- L. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins.

1.4 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600kN-m/m³)).
- B. ASTM D 1556 - Standard Test Method for Density of Soil in Place by Sand-Cone Method.
- C. ASTM D 2922 - Standard Test Methods for Density of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- D. ASTM D 3017 - Standard Test Method for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).
- E. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- F. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- G. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- H. Federal Regulations, 29 CFR, Part 1926, Standards - Excavation, Occupational Safety and Health Administration (OSHA).

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit work plan for excavation and backfill for each structure with complete written description which identifies details of proposed method of construction and sequence of operations for construction relative to excavation and backfill activities. Use descriptions, with supporting illustrations, sufficiently detailed to demonstrate to Engineer that procedures meet requirements of Specifications and Drawings.
- C. Submit excavation safety system plan.
 - 1. Submit excavation safety system plan in accordance with applicable OSHA requirements for excavations.
 - 2. Submit excavation safety system plan in accordance with requirements of Section 02260 - Trench Safety System, for excavations that fall under State and Federal trench safety

laws.

- D. Submit ground and surface water control plan in accordance with requirements in this Section and Section 01578 - Control of Ground Water and Surface Water.
- E. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.
- F. Submit project record documents under provisions of Section 01785 - Project Record Documents. Record location of utilities, as installed, referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.6 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by Authority in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.
- B. Perform embedment and backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. Perform excavation with equipment suitable for achieving requirements of this Specification.
- B. Use equipment which will produce degree of compaction specified. Compact backfill within 3 feet of walls with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to depth of fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

2.2 MATERIAL CLASSIFICATIONS

- A. Use backfill materials conforming to classifications and product descriptions of Section 02320 - Utility Backfill Materials. Use classification or product description for backfill applications as shown on Drawings and as specified.

PART 3 EXECUTION

3.1 PREPARATION

- A. Conduct an inspection to determine condition of existing structures and other permanent installations.
- B. Set up necessary street detours and barricades in preparation for excavation if construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning devices at all times for streets and intersections where work is in progress, or where construction work is considered hazardous to traffic movements. Perform work in accordance with OSHA standards. Employ an excavation safety system as specified in Section 02260 - Trench Safety Systems.
- C. Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- D. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01578 - Control of Ground Water and Surface Water.

3.2 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.
- D. Prevent erosion of excavations and backfill. Do not allow water to pond in excavations.
- E. Maintain excavation and backfill areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density at no additional cost to Authority.

3.3 EXCAVATION

- A. Perform excavation work so that underground structure can be installed to

- depths and alignments shown on Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to absolute minimum necessary. No additional payment will be made for excess excavation not authorized by Engineer.
- B. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Engineer and obtain instructions before proceeding in such areas.
 - C. Immediately notify agency or company owning any line which is damaged, broken or disturbed. Obtain approval from Engineer and agency for any repairs or relocations, either temporary or permanent.
 - D. Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering, or other construction methods.
 - E. Provide surface drainage during construction to protect work and to avoid nuisance to adjoining property. Where required, provide proper dewatering and piezometric pressure control during construction.
 - F. Conduct hauling operations so that trucks and other vehicles do not create dirt nuisance in streets. Verify that truck beds are sufficiently tight and loaded in such a manner such that objectionable materials will not spill onto streets. Promptly clear away any dirt, mud, or other materials that spill onto streets or are deposited onto streets by vehicle tires.
 - G. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed, replace those which are damaged or destroyed by Work.
 - H. Provide sheeting, shoring, and bracing where required to safely complete Work, to prevent excavation from extending beyond limits indicated on Drawings, and to protect Work and adjacent structures or improvements. Use sheeting, shoring, and bracing to protect workmen and public conforming to requirements of Section 02260 - Trench Safety Systems.
 - I. Prevent voids from forming outside of sheeting. Immediately fill voids with grout, cement stabilized sand, or other material approved by Engineer and compact to 95 percent standard density.
 - J. After completion of structure, remove sheeting, shoring, and bracing unless shown on Drawings to remain in place or directed by Engineer in writing that such temporary structures may remain. Remove sheeting, shoring and bracing in such a manner as to maintain safety during backfilling operations and to prevent

damage to Work and adjacent structures or improvements.

- K. Immediately fill and compact voids left or caused by removal of sheeting with cement stabilized sand or other material approved by Engineer and compact to 95 percent standard density.

3.4 HANDLING EXCAVATED MATERIALS

- A. Classify excavated materials. Place material which is suitable for use as backfill in orderly piles at sufficient distance from excavation to prevent slides or cave-ins.
- B. Provide additional backfill material in accordance with requirements of Section 02319 - Borrow, if adequate quantities of suitable material are not available from excavation and trenching operations at site.

3.5 DEWATERING

- A. Provide ground water control per Section 01578 - Control of Ground Water and Surface Water.
- B. Keep ground water surface elevation minimum of 2 feet below bottom of foundation base.
- C. Maintain ground water control as directed by Section 01578 - Control of Ground Water and Surface Water and until structure is sufficiently complete to provide required weight to resist hydrostatic uplift with minimum safety factor of 1.2.

3.6 FOUNDATION EXCAVATION

- A. Notify Engineer at least 48 hours prior to planned completion of foundation excavations. Do not place foundation base until excavation is accepted by Engineer.
- B. Excavate to elevations shown on Drawings, as needed to provide space for foundation base, forming level undisturbed surface, free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with foundation backfill material or material as directed by Engineer. Prior to placing material over it, recompact subgrade where indicated on Drawings, scarifying as needed, to 95 percent of maximum Standard Dry Density according to ASTM D 698. If specified level of compaction cannot be achieved, moisture condition subgrade and recompact until 95 percent is achieved, over-excavate to provide minimum layer of 24 inches of foundation backfill material, or other means acceptable to Engineer.

- C. Fill unauthorized excessive excavation with foundation backfill material or other material as directed by Engineer.
- D. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.
- E. Remove soils which become unsuitable due to inadequate dewatering or other causes, after initial excavation to required subgrade, and replace with foundation backfill material, as directed by Engineer, at no additional cost to Authority.
- F. Place foundation base, or foundation backfill material where needed, over subgrade on same day that excavation is completed to final grade. Where base of excavations are left open for longer periods, protect them with seal slab or cement-stabilized sand.
- G. Use filter fabric as specified in Section 02621 - Geotextile to separate crushed aggregate, and other free draining Class I materials from native soils or select material backfill. Overlap fabric minimum of 12 inches beyond where another material stops contact with soil.
- H. Place crushed aggregate, and other Class I materials, in uniform layers of 8-inch maximum thickness. Perform compaction by means of at least two passes of vibratory compactor.

3.7 FOUNDATION BASE.

- A. Place foundation base after subgrade is properly prepared, including placement of foundation backfill where needed. Use foundation base consisting of 12-inch layer of crushed stone aggregate or cement stabilized sand. Alternately, seal slab with minimum thickness of 4 inches may be placed. Extend foundation base minimum of 12 inches beyond edge of structure foundation, unless shown otherwise on Drawings.
- B. Where foundation base and foundation backfill are of same material, both can be placed in one operation.

3.8 BACKFILL

- A. Complete backfill to surface of natural ground or to lines and grades shown on Drawings. Remove forms, lumber, trash and debris from structures. Deposit backfill in uniform layers and compact each layer as specified.
 - 1. Unless otherwise shown on Drawings, for structures under pavement

or within one foot back of curb, use cement stabilized sand up to the top of the proposed structure. Use suitable on-site material (random backfill) up to 12 inches below pavement base or subgrade. Place minimum of 12 inches of select backfill below pavement base or subgrade.

2. Unless otherwise shown on Drawings, for structures not under pavement, use random backfill of suitable material up to the surface.
- B. Do not place backfill against concrete walls or similar structures until laboratory test breaks indicate that concrete has reached minimum of 85 percent of specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin backfill operations until slab or intermediate walls have been placed and concrete has attained sufficient strength.
- C. Remove concrete forms before starting backfill and remove shoring and bracing as work progresses.
- D. Maintain backfill material at no less than 2 percent below nor more than 2 percent above optimum moisture content, unless otherwise approved by Engineer. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698 below paved areas. Compact fill to at least 90 percent around structures below unpaved areas.
- E. Where backfill is placed against sloped excavation surface, run compaction equipment across boundary of cut slope and backfill to form compacted slope surface for placement of next layer of backfill.
- F. Place backfill using cement stabilized sand in accordance with Section 02321 - Cement Stabilized Sand.

3.9 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Tests will be performed initially on minimum of one different sample of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity.
- C. In-place density tests of compacted subgrade and backfill will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at

following frequencies and conditions:

1. Minimum of one test for every 50 to 100 cubic yards of compacted backfill material as directed by Engineer.
 2. A minimum of three density tests for each full work shift.
 3. Density tests will be performed in all placement areas.
 4. Number of tests will be increased when inspection determines that soil types or moisture contents are not uniform or when compacting effort is variable and not considered sufficient to attain uniform density.
 5. Identify elevation of test with respect to natural ground.
 6. Record approximate depth of lift tested.
- D. At least one test for moisture-density relationships will be initially performed for each type of backfill material in accordance with ASTM D 698. Perform additional moisture-density relationship test once a month or whenever there is noticeable change in material gradation or plasticity.
- E. When tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at Contractor's expense.

3.10 DISPOSAL OF EXCESS MATERIAL

Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. No additional payment will be made for trench excavation, embedment and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
- 2. When Engineer directs Contractor to over excavate trench bottom, Contractor will be paid by unit price bid per linear foot under bid item – 6-inches Over Excavation of Trench Bottom.
 - a. No payment will be paid if Engineer does not direct Contractor to over excavate trench bottom.
 - b. No over excavation will be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 - Control of Ground and Surface Water.
- 3. No additional payment will be made for performing Critical Location exploratory excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
- 4. No additional payment will be made for performing Verification of Pipe Embedment Placement and Compaction. Include cost in unit price for installed underground piping, sewer, conduit or duct work.
- 5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price

1.3 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation backfill material placed and compacted in over-excavations.
- B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.
- D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line 12-inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching and initial backfill.
- F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4-inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.
- I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.
- J. Ground Water Control Systems: Installations external to trench, such as well points,

eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.

- K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.
- L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D 2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.
- M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
 - 1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 - 2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
 - a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
 - b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.
 - 3. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.
- N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.
- O. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.

- P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings, and backfilled with foundation bedding.
- Q. Foundation Bedding: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation bedding is placed and compacted as backfill to provide stable support for bedding. Foundation bedding materials may include concrete seal slabs.
- R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02260 - Trench Safety Systems.
- S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.
- T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
- U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on Drawings.
- V. Vacuum Excavation: An excavation technique performed by an experienced subcontractor in which water or air jetting is used to slough off and vacuum away soil.
- W. Large Diameter Water Line (LDWL): Water line that is 24-inches in diameter or larger.
- X. Emergency Action Plan (EAP): The EAP document should include a discussion of procedures for timely and reliable detection, classification (level of emergency) and response procedure to a potential emergency condition associated with a large diameter water line.
- Y. Subsurface Utility Exploration (SUE): Non-destructive excavation, unless otherwise approved by Engineer.
- Z. Jet Grouting: An in-situ injection technique employed with specialized equipment that includes grout pump(s), grout mixer, drill rig, drill rods and injection monitor with horizontal radial nozzles delivering high velocity fluids to erode, mix, and stabilize in-situ soils using an engineered grout slurry.

1.4 REFERENCES

- A. ASTM A 798 – Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
- B. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- C. ASTM C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures
- D. ASTM C 1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
- E. ASTM C 1675 - Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
- F. ASTM C 1821 - Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures
- G. ASTM D 558 - Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.
- H. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
- I. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- J. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- K. ASTM D 2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil classifications System).
- L. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- M. ASTM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- N. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- O. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- P. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

- Q. ASTM D 7382 – Standard Test Methods for Determination of Maximum Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibrating Hammer.
- R. ASTM D 4914 - Standard Test Methods for Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.

1.5 SCHEDULING

- A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.
- B. For proposed utility adjacent to or across existing LDWL:
 - 1. Conduct a meeting between contractor, Operations and the Authority Engineer prior to beginning excavation to coordinate the EAP in the event a water line shut down becomes necessary.
 - 2. Notify the Engineer a minimum of 1 week prior to beginning construction activities.
 - 3. Notify the Engineer a minimum of 48 hours prior to beginning SUE work near LDWL.
 - 4. Unless otherwise approved by the Engineer, perform construction activities between 7 AM and 7 PM, Monday through Friday. No work permitted around a LDWL on weekends or Authority Holiday.
 - 5. An Authority Representative must be present during SUE or construction activities occurring within four feet or one diameter of the LDWL, whichever is greater, from a LDWL or appurtenance.

1.6 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit planned typical method of excavation, backfill placement and compaction including:
 - 1. Sequence of work and coordination of activities.
 - 2. Trench widths.
 - 3. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.

4. Procedures for assuring compaction against undisturbed soil when use of trench boxes or other pre-manufactured trench safety systems are proposed.
5. Groundwater and surface water control plan.
- C. Submit backfill material sources and product quality information, including flowable fill and concrete encasement mix designs and historic break results, in accordance with requirements of Section 02320 - Utility Backfill Materials.
- D. Submit trench excavation safety program in accordance with requirements of Section 02260 - Trench Safety System. Include designs for special shoring meeting requirements defined in Paragraph 1.8, Special Shoring Design Requirements contained herein.
- E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.
- F. Submit 11-inch by 17-inch or 12-inch by 18-inch copy of Drawing with plotted utility or obstruction location titled "Critical Location Report" to Engineer.
- G. For installation of proposed utility adjacent to or across existing LDWL, prepare and submit the following to the Engineer prior to beginning construction activities. Obtain approval from the Engineer prior to commencing pre-locate or utility work near LDWL.
 1. Trench details, shoring system designs, installation sequences, and flowable fill mix designs.
 2. Emergency Action Plan (EAP) to address contingency plans in the event of damage to or failure of LDWL. Include the following:
 - a. Contact personnel and agencies including primary and secondary telephone numbers.
 - b. Contractor's hierarchy of responsible personnel.
 - c. Traffic control measures.
 - d. Identification of resources to be available on or near project site in event of damage to or failure of LDWL.

1.7 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during

construction will be performed by an independent laboratory provided by the Authority in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.

- B. Use of existing material from trench excavations will require testing to confirm applicable specification requirements are met. Contractor may pot-hole every 1000-ft along route to confirm material from trench excavations meet specification requirements. Pot-holing and testing for existing material to be completed in advance of excavation as to not create delays.
- C. Perform backfill material source qualification testing in accordance with requirements of Section 02320 - Utility Backfill Materials.

1.8 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by Contractor's Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a pre-manufactured system selected by Contractor's Professional Engineer to meet project site requirements based on manufacturer's standard design.

PART 2 P R O D U C T S

2.1 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
- B. Use only hand-operated tamping equipment until minimum cover of 12-inches is obtained over pipes, conduits, and ducts when using sand for embedment and backfill materials. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.
- D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.2 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials and Section

02321 – Cement Stabilized Sand.

- B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315- Concrete for Utility Construction.
- C. Geotextile (Filter Fabric): Conform to requirements of Section 02621- Geotextile.
- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.
- E. Flowable Fill: Conform to requirements of Section 02322 – Flowable Fill.

PART 3 EXECUTION

3.1 STANDARD PRACTICE

- A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321 or AWWA 604 as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
- B. Install rigid pipe to conform to standard practice described in ASTM C 12, C 1479, or C 1675 as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

3.2 PREPARATION

- A. Establish traffic control to conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.
- B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 - Trench Safety Systems.
- C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Engineer and agency for any repairs or relocations, either temporary or permanent.
- D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02221 - Removing Existing Pavements, Structures, Wood and Demolition Debris, as applicable.
- E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01578 - Control of Ground and Surface Water. Provide stable trench to allow installation in accordance with Specifications. If jet grouting is required to cut off the ground water and provide excavation support, installation of jet grouting shall comply

with Specifications.

- F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 - Field Surveying.
- G. Limit concrete removal, pavement removal and dewatering to less than five pipe laying days in advance of pipe laying.

3.3 CRITICAL LOCATION INVESTIGATION

- A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. Unless otherwise approved by the Engineer, at Critical Locations shown on Drawings, perform vacuum excavation to field verify horizontal and vertical locations of such lines within a zone 2 feet vertically and 4 feet horizontally of proposed work exclude water jetting at PCCP water line.
 - 1. Verify location of existing utilities that have not identified in Drawings as Level A SUE located utility prior to pipe manufacturing. Verification of existing utilities prior to manufacturing pipe may be delayed with Engineer approval. Use extreme caution and care when uncovering utilities designated by Critical Locate.
 - 2. Verify location of existing utilities, not verified prior to pipe manufacturing, a minimum of 7 working days in advance of pipe laying activities based on daily pipe laying rate or prior to beginning installation of auger pit or tunnel shaft. Use extreme caution and care when uncovering utilities designated by Critical Locate.
 - 3. Notify the Engineer in writing immediately upon identification of obstruction per requirements defined in Article 5.05 of General Conditions.
- B. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Engineer with 48 hours notice prior to field excavation or related work.
- C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 11-inch by 17-inch OR 12-inch by 18-inch copy of Drawings. For large diameter water lines, submit to the Engineer for approval, horizontal and vertical alignment dimensions for connections to existing lines, tied into project baseline, signed and sealed by R.P.L.S.

D. LDWL Pre-locate Requirements:

1. Field-locate LDWL, appurtenances and laterals connected directly to LDWL through use of non-probing method such as a vacuum truck (non-water jetting method) at no greater than 50-foot intervals. Locate upstream and downstream of proposed work or utility installation.
2. Record crown and side of LDWL adjacent to proposed work or utility installation. Record LDWL locations horizontally and vertically using same coordinate system employed on proposed utility drawings.
3. Tie horizontal and vertical coordinates into project baseline. Submit recordings performed by R.P.L.S to the Authority a minimum of 14 days prior to mobilizing to site.

3.4 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.
- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, re-compact, and pave those areas at no additional cost to the Authority.
- E. Contingency plans for proposed work or utility installation adjacent to or across a LDWL:
 1. Conduct on-site emergency drill prior to commencing proposed utility installation, and at three month intervals to assure EAP is current.
 2. In the event a LDWL shut down becomes necessary, secure site and provide assistance to the Authority personnel to access pipe and isolation valves as needed.

3.5 EXCAVATION

- A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and

alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.

- C. Determine trench excavation widths using following schedule as related to pipe outside diameter (O.D.) unless Drawings show different trench widths. Excavate trench so that pipe is centered in trench.

Nominal Pipe Size, Inches	Minimum Trench Width, Inches
Less than 18	O.D. + 18
18 to 30	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

- D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.
- E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify the Engineer and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
1. Comply with Specification Section 02260 – Trench Safety System
 2. Where Special Shoring is required, install in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.
 3. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.
 4. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by the Engineer. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.
 5. Employ special methods for maintaining integrity of embedment or foundation

- material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
6. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.
- G. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:
1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
 2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re-compact after shield is moved if soil is disturbed.
 3. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
 4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.
 5. Conform to applicable Government regulations.
- H. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.
- I. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.
- J. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of Pipeline Company's line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not

place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company's representative.

- K. When, during excavation to uncover pipeline company's pipelines, screwed collar or an oxy- acetylene weld is exposed, immediately notify the Engineer. Provide supports for collar or welds. Discuss with Pipeline Company's representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.
- L. Excavation and shoring requirements for proposed work or utility installation adjacent to or across a LDWL:
 - 1. Identify LDWL area in field and barricade off from construction activities. Allow no construction related activities including, but not limited to, loading of dump trucks and material staging or storage, on top of LDWL.
 - 2. Employ a groundwater control system when performing excavation activities within ten feet of LDWL to:
 - a. Effectively reduce hydrostatic pressure affecting excavations,
 - b. Develop substantially dry and stable subgrade for subsequent construction operations,
 - c. Prevent loss of fines, seepage, boils, quick condition or softening of foundation strata, and
 - d. Maintain stability of sides and bottom of excavations.
 - 3. When edge of proposed trench or shoring is within a distance equal to one diameter of LDWL from outside of wall of LDWL, valve or appurtenance:
 - a. Maintain minimum of four (4) feet horizontal clearance and minimum of two (2) feet vertical clearance between proposed utility and LDWL.
 - b. Auger Construction
 - i. Maintain minimum of four (4) feet horizontal clearance between proposed utility and LDWL.
 - ii. Dry auger method required when auger hole is 12-inches and larger in diameter.
 - c. Open Cut Construction and Auger pits

- i. Perform hand excavation when within four (4) feet of LDWL.
 - ii. Employ hydraulic or pneumatic shoring system. Do not use vibratory or impact driven shoring or piling.
 - iii. Expose no more than 30-feet of trench prior to backfilling.
 - iv. A maximum of one (1) foot of vertical trench shall be unbraced at a time to maintain constant pressure on face of excavated soil.
 - v. Upon removal of shoring system, inject flowable fill into void space left behind by shoring system. Comply with Standard Specification 02322 - Flowable Fill.
- d. When edge of utility excavation is greater than one diameter of LDWL from outside wall of LDWL, use a shielding system as required by Engineer and proposed utility standards and practices.

3.6 HANDLING EXCAVATED MATERIALS

- A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02320 - Utility Backfill Materials.
- B. Separate and store topsoil in wetland defined areas as shown on Drawings or where existing topsoil will be reused for restoration.
- C. When required, provide additional backfill material conforming to requirements of Section 02320 - Utility Backfill Materials.
- D. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins. Maintain site conditions in accordance with Section 01504 - Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.
- E. Do not block pre-construction drainage flow or adversely impact flood control. Temporary fill and stockpiles excavated material shall be placed in a manner that does not impact site drainage, and such that will not be eroded by high flows from nearby drainage features.

3.7 TRENCH FOUNDATION

- A. Excavate bottom of trench to uniform grade to achieve stable trench

conditions and satisfactory compaction of foundation or bedding materials.

- B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional 6-inches with approval by the Engineer. Place non-woven geotextile fabric and then compact 6-inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment. Install remaining 6-inches of crush stone loose prior to setting pipe.
- C. Perform over excavation, when directed by the Engineer, in accordance with Paragraph 3.7B above. Removal of unstable or unsuitable material may be required if approved by Engineer;
 - 1. Even though Contractor has not determined material to be unsuitable, or
 - 2. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 - Control of Ground and Surface Water.

3.8 PIPE EMBEDMENT, PLACEMENT AND COMPACTION

- A. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.
- B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings. When uncompacted bedding is required, place bedding to a depth slightly above the bottom of pipe grade, and lay pipe on this material to the indicated grade. Adjust bedding depth as needed so that pipe will settle to indicated grade. Provide bell holes to permit the pipe to rest on the full length of the barrel and permit joint make-up and coating or installation of pipe wrapper.
- C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction of backfill material directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
- D. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.
- E. Place geotextile to prevent particle migration from in-situ soil into embedment materials when the following are used for embedment:
 - 1. Open-graded (Class I) embedment materials or drainage layers.

2. Well or poor-graded gravels, well or poor-graded gravel-sand mixtures, well or poor graded crushed stone, and pea gravel.
 3. When required, geotextile shall wrap the entirety of the embedment and have a minimum 12-inch overlap with adjoining sections. In cases where embedment does not extend over top of pipe, wrap embedment and exposed pipe with geotextile.
- F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. Avoid dropping embedment and backfill materials directly onto pipe. Notify Engineer if any damage occurs and obtain approval for repair procedures. Repair any damage which occurs.
- G. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. Take care to ensure material is fully placed and compacted under the haunches. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.
- H. Place electrical conduit, if used, directly on foundation without bedding.
- I. Compact cohesionless (Class I and II) soils using vibratory methods. Pea Gravel and crushed limestone may also be placed using large compaction wheels mounted on an excavator if compaction requirements are met. Compact Class III and IV materials using impact or kneading methods and use a of pneumatic backfill tampers under the haunches. For dual classification soils, utilize most effective method to achieve maximum compaction. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
- J. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas; or as appropriate to backfill material as directed by the Engineer. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
- K. For constructing water line embedment, use bank run sand, concrete sand, gem sand, pea gravel, crushed limestone, cement stabilized sand, or flowable fill as specified in Section 02320 - Utility Backfill Material. Use same embedment material for the entire project extents, with the exception of cement stabilized sand or flowable fill where required for special installations or as required per Drawings. Adhere to the following subparagraph numbers 1 through 4.
1. Class I and II Embedment Materials
 - a. Lift thickness
 - i. Bank run sand, concrete sand, or gem sand: Maximum 6-inches

- compacted lift thickness in the entirety of embedment zone.
 - ii. Pea gravel or crushed limestone: Maximum 6-inches compacted lift thickness for placement of granular embedment between bottom of trench to a height 0.3 times the outside diameter of the pipe, measured from the invert. The remainder of the pipe embedment zone above the 6-inch lift area may be increased to 18-inch lifts to the top of the embedment zone.
 - b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698 , ASTM D 4253, or ASTM D 7382 as applicable.
 - c. For materials that contain 10 percent or more particles passing the number 200 sieve and dual classification materials, determine maximum density and optimum moisture according to ASTM D 698. If maximum density determined using ASTM D 698 is greater than that determined using ASTM D 4253 or ASTM D 7382, compact embedment material to achieve a minimum 95% of maximum dry density according to ASTM D 698. Keep moisture content to within -3 percent to +5 percent of optimum as determined according to ASTM D 698.
 - d. Class I cohesionless embedment materials moisture content to be determined by Contractor for effective compaction without softening of soil trench bottom, foundation, or trench walls.
- 2. Class III Embedment Materials (36-inch diameter waterline and smaller)
 - a. Class III Embedment Materials only allowed for waterline diameters less than 36-inches.
 - b. Maximum 6-inches compacted lift thickness.
 - c. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - d. Moisture content to within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Engineer.
- 3. Cement Stabilized Sand (where required for special installations):
 - a. Maximum 6-inches compacted thickness.
 - b. Compact to achieve minimum of 95 percent of maximum dry

- density as determined according to ASTM D 558.
- c. Moisture content to be on dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.
4. Flowable Fill (where required for special installations):
- a. The pipe shall be blocked on sand bags or sack-crete burlap bags to allow a minim thickness, as indicated on Drawings, of flowable fill below the pipe. The number and spacing of sand bags shall be such that integrity of the pipe is not compromised.
 - b. Pour flowable fill in multiple lifts. When subsequent lifts of flowable fill are to be placed, keep the surface of the flowable fill moist until subsequent lifts are placed.
 - c. Deposit flowable fill in a manner that forms a compact, dense, impervious mass free of voids. Flowable fill shall be placed against undisturbed trench walls.
 - d. Control lifts to prevent pipe from shifting or floating.
 - e. Do not apply flowable fill if water is present in trench. Dewater trench and groundwater sufficiently to provide dry conditions.
 - f. Prior to placing overlying backfill, flowable fill shall be allowed to cure sufficiently to prevent deformation.
- L. For Sanitary Sewers adhere to the following subparagraph numbers 1 and 2. For Storm Sewers provide cement stabilized sand per paragraph 2. This provision does not apply to Storm Sewers constructed of HDPE pipe installed under pavement.
1. Class I Embedment Materials.
- a. Maximum 6-inches compacted lift thickness.
 - b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.
 - c. Moisture content as determined by Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.

2. Class II Embedment and Cement Stabilized Sand.
 - a. Maximum 6-inches compacted thickness.
 - b. Compaction by methods determined by Contractor to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.
 - c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.
- M. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill pipe embedment as specified in Section 02322 - Flowable Fill.
- N. Trench Dams:
 1. General Trench Dam Requirements:
 - a. Do not place trench dams closer than 5 feet from manholes.
 - b. Trench section backfilled with cement stabilized sand or flowable fill shall meet the definition of a trench dam under this Specification.
 - c. Refer to the Drawings for trench dam construction details.
 - d. Show trench dam locations on As-Built Drawings.
 2. For all utilities except water lines 36-inches diameter and above, place trench dams when using Class I embedment materials at the following locations.
 - a. Between manhole structures unless the manholes are less than 100 feet apart.
 - b. Not less than one for every 500 feet of pipe placed.
 - c. As required to control groundwater in trench during pipeline installation and as otherwise needed to achieve workable construction conditions.
 - d. Do not place trench dams closer than 5 feet from manholes.

3. For all water lines 36-inches diameter and above with bank run sand embedment, place trench dams per the following requirements.
 - a. Trench dam locations shown on Drawings assume granular cohesionless Class 1 or II embedment materials. Contractor to submit proposed trench dam locations if bank run sand is used at the embedment material per the requirements of this section.
 - b. Trench dams to be placed at any crossing where the pipe elevation changes by more than one pipe diameter including creek, ditch, roadway, tunnel, or utility offset crossings. Place Trench Dam within 5 feet of the vertical alignment change on the high side.
 - c. As required to control groundwater in trench during pipeline installation and as otherwise needed to achieve workable construction conditions.
4. For all water lines 36-inches diameter and above, place trench dams in Class I or II embedment per the following requirements.
 - a. As shown on Drawings, unless bank run sand is used as embedment material.
 - b. As required to control groundwater in trench during pipeline installation and as otherwise needed to achieve workable construction conditions.
 - c. Between manhole structures unless the manholes are less than 100 feet apart.
 - d. Not less than one in every 500 feet of pipe placed when pipeline is set a slope less than 1%.
5. Place trench dams at the following locations when potentially petroleum contaminated areas (PPCAs) or other contaminants are present.
 - a. At property lines when property contains limits of potentially petroleum contaminated areas (PPCAs) or other contaminants are present anywhere on the property.
 - b. At property lines when pipeline crosses from road right-of-way into easement or private property, and when the road right-of-way is in the limits of PPCA or contains other contaminants.
 - c. At each boundary of PPCA per Specification Section 02105.
 - d. As required to control groundwater in trench during pipeline

installation and as otherwise needed to achieve workable construction conditions.

O. Verification of Pipe Embedment Placement and Compaction

1. At the beginning of pipe laying operations, for each pipelaying crew, the Contractor shall perform an open-cut demonstration section to demonstrate that the methods and materials to be utilized will satisfy compaction requirements for the pipe foundation, pipe zone, and area above the pipe zone in accordance with this Section and the contract drawings
2. The minimum length of the demonstration section shall be two (2) pipe sections including one pipe joint. Pipe shall be embedded in accordance with this Section and then removed for Engineer to inspect and verify conformance to embedment requirements.
3. The Contractor shall not proceed with production pipe laying beyond the demonstration section without the Engineer's approval.
4. The entire demonstration section length that does not comply with the Contract Documents shall be reworked as necessary to comply.
5. The Engineer will observe construction of the demonstration section.
6. The Engineer will take measurements and keep records for quality assurance purposes.
7. Any change in means, methods, and trench conditions, and backfill and compaction methods, and welding will require another successful demonstration section before additional production pipe installation.

3.9 TRENCH ZONE BACKFILL, PLACEMENT AND COMPACTION

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.
- B. For water lines, under pavement and to within one foot back of curb, use backfill materials described below:
 1. For water lines 20-inches in diameter and smaller, use bank run sand or select backfill materials up to pavement base or subgrade.
 2. For water lines 24-inches in diameter and larger, use bank run sand or select backfill materials up to pavement base or subgrade.
- C. For sewer pipes (Storm and Sanitary), use backfill materials described by trench limits. For

"trench zone backfill" under pavement and to within one foot back of curb, use cement stabilized sand for pipes of nominal sizes 36-inches in diameter and smaller to level 12 inches below the pavement. For sewer pipes 42-inches in diameter and larger, under pavement or natural ground, backfill from 12-inches above top of pipe to 12-inches below pavement with suitable on-site material or select backfill. Use select backfill for rigid pavements or flexible base material for asphalt pavements for 12- inch backfill directly under pavement. For backfill materials reference Section 02320 - Utility Backfill Materials. This provision does not apply where a Storm Sewer is constructed of any flexible pipe product.

- D. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill as specified in Section 02322 - Flowable Fill. For Storm Sewers constructed of any flexible pipe product and not installed under pavement provide cement stabilized sand.
- E. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5-feet or more above crown of pipe. Remove trench supports within 5-feet from ground surface.
- F. Unless otherwise shown on Drawings, use one of the following trench zone backfills under pavement and to within one foot of edge of pavement. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.
 - 1. Class I, II, or III or combination thereof:
 - a. Place in maximum 12-inch thick loose layers.
 - b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 698.
 - c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless otherwise approved by the Engineer.
 - 2. Cement-Stabilized Sand:
 - a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12 inches.
 - b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 558.
 - c. Moisture content on dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Class IVA and IVB (Clay Soils):
 - a. Place in maximum 8-inch thick loose lifts.
 - b. Compaction by vibratory Sheepfoot roller to minimum of 95 percent of maximum dry density determined according to ASTM D 698.
 - c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless approved by the Engineer.
- G. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of suitable material may be used in trench zone. This provision does not apply to flexible pipe used for storm sewers.
 1. Fat clays (CH) may be used as trench zone backfill outside paved areas at Contractor's option. When required density is not achieved, at any additional cost to the Authority, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements, or use different suitable material.
 2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
 3. Compact to minimum of 95 percent of maximum dry density determined according to ASTM D 698.
 4. Moisture content as necessary to achieve density.
 5. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

- A. Below paved areas or where shown on Drawings, encapsulate manhole with cement stabilized sand or flowable fill; minimum of 2 foot below base, minimum 2 foot around walls, up to pavement subgrade or natural ground. Compact in accordance with Paragraph 3.9.F of this Section
- B. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on Drawings. Deposit backfill in uniform layers and compact each layer as specified. Maintain backfill material at no less than 2 percent below nor more than 5 percent above optimum moisture content, unless otherwise approved by the Engineer. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698.

- C. For LDWL projects, encapsulate manhole with cement stabilized sand or flowable fill; minimum of 1 foot below base, minimum of 2 feet around walls, and up to within 12 inches of pavement subgrade or natural ground. For manholes over water line, extend encapsulation to bottom of trench. Compact in accordance with Paragraph 3.9 F of this Section.

3.11 FIELD QUALITY CONTROL

- A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.
- B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to the Authority.
- C. Tests will be performed on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity, or when requested by the Engineer.
- D. At least three tests for moisture-density relationships will be performed initially for Class III, Class IV, and Class II (with amount passing the number 200 sieve greater than 10%) embedment and backfill materials in accordance with ASTM D 698, and for cement-stabilized sand in accordance with ASTM D 558. At least three test for maximum index density and unit weight in accordance with ASTM D 4253 or for maximum dry unit weight and water content range for effective compaction in accordance with ASTM D 7382 will be initially performed for cohesionless (Class I and Class II) embedment and backfill materials. Perform additional moisture-density relationship tests for every 5,000 CY of material used, once a month, or whenever there is noticeable change in material gradation or plasticity, whichever is more stringent.
- E. The Authority's testing lab will complete, at a minimum, in-place density tests of compacted pipe foundation, embedment, and trench zone backfill soil materials will be performed according to ASTM D 1556, ASTM D 4914 or ASTM D 6938, and at following frequencies and conditions.
 - 1. For open cut construction projects, auger pits, and tunnel shafts: Unless otherwise approved by the Engineer, successful compaction to be measured to the following frequencies every 50 linear feet measured along pipe:
 - a. For pipe 48-inch in diameter and less: At least two test of compacted embedment materials.
 - b. For pipes over 48-inches in diameter: At least one test of compacted embedment materials for each 12-inch thickness of embedment

materials.

- c. At least two tests for compacted trench zone backfill material.
 - d. Length of auger pits and tunnel shafts to be measured to arrive at 50 linear feet. Testing frequencies in auger pits and tunnel shafts to comply with requirements of subparagraphs a, b, and c above.
 - 2. A minimum of three density tests per compacted material type for each full shift of Work.
 - 3. Density tests will be distributed among placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.
 - 4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
 - 5. Density tests may be performed at various depths below fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
 - 6. Two verification tests will be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
 - 7. Re-compacted placement will be retested at same frequency as first test series, including verification tests.
 - 8. Identify elevation of test with respect to natural ground or pavement and station location.
- F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.
- G. Acceptability of crushed rock compaction will be determined by inspection as determined by the Engineer.

3.12 DISPOSAL OF EXCESS MATERIAL

- A. Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02318

EXTRA UNIT PRICE WORK FOR EXCAVATION AND BACKFILL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Measurement and payment applicable to extra unit price work items for excavation and backfill made necessary by unusual or unforeseen circumstances encountered during utility installations.
- B. Extra unit price work for excavation and backfill is paid only when authorized in advance by Engineer.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. Excavation Around Obstructions: Payment for excavation around obstructions is on cubic yard basis, measured in place, without deduction for volume occupied by portions of pipes, ducts, or other structures left in place across trenches excavated under this item.
- 2. Extra Hand Excavation: Payment for extra hand excavation is on cubic yard basis, measured in place.
- 3. Extra Machine Excavation: Payment for extra machine excavation is on cubic yard basis, measured in place.
- 4. Extra Placement of Backfill Material: Payment for extra placement of backfill material is on cubic yard basis, measured in place, for material installed as part of Work. At discretion of Engineer, measurement of cubic yards may be calculated from volume of Extra Hand Excavation or Extra Machine Excavation for which replacement is made, minus volume of any Extra Placement of Granular Backfill authorized in conjunction with Work.
- 5. Extra Placement of Granular Backfill: Payment for extra placement of granular backfill material is on cubic yard basis, measured in place.
- 6. Extra Select Backfill: Payment for extra select backfill is on cubic yard

basis, measured in place for a theoretical minimum trench width. The Engineer may authorize extra select backfill when soil from the excavation work does not include adequate quantities for placement of suitable on-site material (random backfill).

7. Refer to Section 01270 – Measurement and payment for unit price procedures.

1.3 DEFINITIONS

- A. **Excavation Around Obstructions:** Excavation necessitated by obstruction of pipes (other than service connections 3 inches in diameter or less), ducts, or other structures, not shown on Drawings, and of an unusual or unforeseen nature which interfere with installation of utility piping by normal methods of excavation or auguring.
- B. **Extra Hand Excavation:** Excavation by manual labor made necessary by unusual or unforeseen circumstances at locations approved in advance by Engineer.
- C. **Extra Machine Excavation:** Excavation by machine at or near project site to perform related work not included in original project scope but added for convenience of Authority, as approved in advance by Engineer.
- D. **Extra Replacement of Backfill Material:** Handling, backfill, and compaction of excavated material authorized under extra work bid items for Extra Hand Excavation or Extra Machine Excavation. Placement and compaction shall conform to requirements specified for excavation and backfill in Sections 02316 – Excavation and Backfill for Structures and 02317– Excavation and Backfill for Utilities.
- E. **Extra Placement of Granular Backfill:** Hauling, placing, and compacting granular backfill materials as approved by Engineer in conjunction with Extra Replacement of Backfill Material. Materials placed under this item shall conform to requirements for Bank Run Sand, Cement Stabilized Sand, Concrete Sand, Gem Sand, Crushed Stone, or Crushed Concrete specified for backfill material in Sections 02316 – Excavation and Backfill for Structures and 02317 – Excavation and Backfill for Utilities.
- F. **Extra Select Backfill:** Unsuitable material removed from the project and select backfill material hauled to the project, or conditioning unsuitable material on the site to make it select backfill. Provide select backfill material specified in Section 02320 – Utility Backfill Materials.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION Not Used

END OF SECTION

Section 02319

BORROW

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Soil materials for embankment or backfill.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for borrow is on cubic yard basis calculated by theoretical quantities using average end area method based on Drawings.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
- B. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit location and description of proposed borrow area for approval.
- C. Submit material samples for testing.

PART 2 P R O D U C T S

2.1 SOIL MATERIAL

- A. Grade borrow material used for embankment or backfill free of lumps greater than 6 inches, rocks larger than 3 inches, organic material, chemical waste or other contamination, and debris. Take borrow material from sources approved by Engineer.
- B. Use material with plasticity index not less than 12, nor more than 20 when tested in accordance with ASTM D 4318. Maximum liquid limit shall be 45, unless approved by Engineer. Do not blend cohesive and granular soils to achieve required plasticity index.

PART 3 E X E C U T I O N

3.1 PREPARATION

- A. Notify Engineer and testing laboratory 5 days in advance of opening borrow source to permit obtaining samples for qualification testing. When material does not meet specification requirements, locate another source of borrow.
- B. Clear approved source area of trees, stumps, brush, roots, vegetation, organic matter, and other unacceptable material before excavation.

3.2 TESTS

- A. Test and analyze soil materials in accordance with ASTM D 4318 and ASTM D 2216 under provisions of Section 01454 - Testing Laboratory Services.

3.3 EXCAVATION

- A. Provide adequate drainage of surface water so that surface water run off does not enter borrow pit excavation.

3.4 HAULING

- A. Use covered trucks. Conform to requirements of Section 01555 - Traffic Control and Regulation.

3.5 EMBANKMENT

- A. Conform to requirements of Section 02330 - Embankment.

END OF SECTION

Section 02320

UTILITY BACKFILL MATERIALS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

A. Material Classifications.

B. Utility Backfill Materials:

1. Concrete sand
2. Gem sand
3. Pea gravel
4. Crushed stone
5. Bank run sand
6. Select backfill
7. Random backfill
8. Cement stabilized sand
9. Flowable Fill

C. Material Handling and Quality Control Requirements.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for backfill material. Include payment in unit price for applicable utility installation.
2. Payment for backfill material, when included as separate pay item or when directed by Engineer, is on cubic yard basis for material placed and compacted within theoretical trench width limits and thickness of material according to Drawings, or as directed by Engineer.

3. Payment for backfill of authorized over-excavation is in accordance with Section 02318 - Extra Unit Price Work for Excavation and Backfill.
 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 DEFINITIONS

- A. Unsuitable Material:
1. Materials classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 3. Materials containing large clods, aggregates, or stones greater than 4 inches in any dimension; debris, vegetation, or waste; or any other deleterious materials.
 4. Materials contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material:
1. Materials meeting specification requirements.
 2. Unsuitable materials meeting specification requirements for suitable soils after treatment with lime or cement.
- C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.
- D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.
- E. Backfill Material: Classified soil material meeting specified quality requirements for designated application as embedment or trench zone

backfill.

- F. Embedment Material: Soil material placed under controlled conditions within embedment zone extending vertically upward from top of foundation to an elevation 12 inches above top of pipe, and including pipe bedding, haunching and initial backfill.
- G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in trench zone from top of embedment zone to base course in paved areas or to surface grading material in unpaved areas.
- H. Foundation: Either suitable soil of trench bottom or material placed as backfill of over- excavation for removal and replacement of unsuitable or otherwise unstable soils.
- I. Source: Source selected by Contractor for supply of embedment or trench zone backfill material. Selected source may be project excavation, off-site borrow pits, commercial borrow pits, or sand and aggregate production or manufacturing plants.
- J. Refer to Section 02317 - Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.4 REFERENCES

- A. ASTM C 33 - Standard Specification for Concrete Aggregate.
- B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.
- D. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in Los Angeles Machine.
- E. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. ASTM D 1140 - Standard Test Method for Amount of Material in Soils Finer

Than No. 200 Sieve.

- H. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- I. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- J. ASTM D 4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Method.
- K. TxDOT Tex-110-E - Determining Particle Size Analysis of Soils.
- L. TxDOT Tex-460-A - Material Finer Than 75 μ m (No.200) Sieve In Mineral Aggregates (Decantation Test for Concrete Aggregates).

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit description of source, material classification and product description, production method, and application of backfill materials.
 - 1. When flowable fill or concrete encasement is used, submit design mix and break results adhering to the requirements of Section 02322 - Flowable Fill
- C. Submit certified test results for samples of off-site backfill materials. Comply with Paragraph 2.3, Material Testing.
- D. Before stockpiling materials, submit copy of approval from landowner for stockpiling backfill material on private property.
- E. Provide delivery ticket which includes source location for each delivery of material that is obtained from off-site sources or is being paid as specific bid item.

1.6 TESTS

- A. Perform tests of sources for backfill material in accordance with Paragraph 2.3B.
- B. Verification tests of backfill materials may be performed by Authority in accordance with Section 01454 - Testing Laboratory Services and in accordance with Paragraph 3.3.

PART 2 PRODUCTS

2.1 MATERIAL CLASSIFICATIONS

2.1 Classify materials for backfill for purpose of quality control in accordance with Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01 B, or by product descriptions, as given in Paragraph 2.02.

A. Class Designations Based on Laboratory Testing:

1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
 - a. Plasticity index: non-plastic.
 - b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines (GM, GP, SP, SM):
 - a. Plasticity index: non-plastic to 4.
 - b. Gradations:
 - 1) Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
 - 2) Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
 - 3) Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
 - a. Plasticity index: greater than 7.
 - b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
4. Class IVA: Lean clays (CL).
 - a. Plasticity Indexes:
 - 1) Plasticity index: greater than 7, and above A line.

- 2) Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
 - b. Liquid limit: less than 50.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
5. Class IVB: Fat clays (CH)
 - a. Plasticity index: above A line.
 - b. Liquid limit: 50 or greater.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to more restrictive class.

2.2 PRODUCT DESCRIPTIONS

- A. Soils classified as silt (ML) silty clay (CL-ML with PI of 4 to 7), elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as backfill materials. These soils may be used for site grading and restoration in unimproved areas as approved by Engineer. Soils in Class IVB, fat clay (CH) may be used as backfill materials where allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.
- B. Provide backfill material that is free of stones greater than 6 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to following limits for deleterious materials:
 1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.
 2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.
 3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.

- C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in product specification, and approved by Engineer, provided that physical property criteria are determined to be satisfactory by testing.
- D. Bank Run Sand: Durable bank run sand classified as SP, SW, or SM by Unified Soil Classification System (ASTM D 2487) meeting following requirements:
1. Less than 15 percent passing number 200 sieve when tested in accordance with ASTM D 1140. Amount of clay lumps or balls may not exceed 2 percent.
 2. Material passing number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318: Plasticity index: not exceeding 7.
- E. Concrete Sand: Natural sand, manufactured sand, or combination of natural and manufactured sand conforming to requirements of ASTM C 33 and graded within following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- F. Gem Sand: Sand conforming to requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	95 to 100
No. 4	60 to 80
No. 8	15 to 40

- G. Pea Gravel: Durable particles composed of small, smooth,

rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for same construction activity from single source, unless otherwise approved by Engineer.
2. Non-plastic fines.
3. Los Angeles abrasion test wear not exceeding 45 percent when tested in accordance with ASTM C 131.
4. Crushed aggregate shall have minimum of 90 percent of particles retained on No. 4 sieve with 2 or more crushed faces as determined by Tex-460-A, Part I.
5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from naturally occurring single source. Uncrushed gravel is not acceptable materials for embedment except where crushed stone is shown on applicable utility embedment drawing details.
6. Gradations, as determined in accordance with Tex-110-E.

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipes Sizes		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 - 100	100
1/2"	25 - 60	-	90 - 100
3/8"	-	20 - 55	40 - 70

No. 4	0 - 10	0 - 10	0 - 15
No. 8	0 - 5	0 - 5	0 - 5

- I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with plasticity index between 7 and 20 or clayey soils treated with lime in accordance with Section 02951 - Pavement Repair and Restoration to meet plasticity criteria.
- J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fat clay (CH) wh allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.
- K. Cement Stabilized Sand: Conform to requirements of Section 02321 - Cement Stabilized Sand.
- L. Concrete Backfill: Conform to Class B concrete as specified in Section 03315 - Concrete for Utility Construction.
- M. Flexible Base Course Material: Conform to requirements of applicable portions of Section 02711 - Hot Mix Asphaltic Base Course, Section 02712 - Cement Stabilized Base Course, and Section 02713 - Recycled Crushed Concrete Base Course.
- N. Rock for Subaqueous Pipe Embedment and Backfill. Shall be as specified in Paragraph H – Crushed Aggregates this Section.
- O. Rock for Subaqueous Pipe Foundation.

Consist of durable particles of crushed stone free of silt, clay, or other unsuitable materials and have a percentage of wear of not more than 40% when tested in accordance with ASTM C131 or ASTM C535. When material is subjected to five (5) cycles of the sodium sulfate soundness test in accordance with ASTM C88, the weighted percentage of loss shall not exceed 12%. The source of the material shall be approved by the OPT and meet the following gradation in accordance with ASTM D448, size number 1:

<u>Sieve Size</u>	
Square Opening	Percent Passing
4"	100
3-1/2"	90 - 100
2-1/2"	25 - 60
1-1/2"	05 - 15
3/4	0 - 5

2.3 MATERIAL TESTING

- A. Source Qualification. Perform testing to obtain tests by suppliers for selection of material sources and products not from the project site. Test samples of processed materials from current production representing material to be delivered. Use tests to verify that materials meet specification requirements. Repeat qualification test procedures each time source characteristics change or there is planned change in source location or supplier. Include the following qualification tests, as applicable:
1. Gradation. Report complete sieve analyses regardless of specified control sieves from largest particle through No. 200 sieve.
 2. Plasticity of material passing No. 40 sieve
 3. Los Angeles abrasion wear of material retained on No. 4 sieve
 4. Clay lumps
 5. Lightweight pieces
 6. Organic impurities
- B. Production Testing. Provide reports to Engineer from an independent testing laboratory that backfill materials to be placed in Work meet applicable specification requirements.
- C. Assist Engineer in obtaining material samples for verification testing at source or at production plant.

PART 3 E X E C U T I O N

3.1 SOURCES

- A. Use of existing material in trench excavations is acceptable, provided applicable specification requirements are satisfied.
- B. Identify off-site sources for backfill materials at least 14 days ahead of intended use so that Engineer may obtain samples for verification testing.
- C. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet requirements of specifications will be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination. Once material is approved by Engineer, expense for sampling and testing required to change to different material will be credited to Authority through change order.
- D. Bank run sand, select backfill, and random backfill, if available in project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete work from off-site sources.
- E. Authority does not represent or guarantee that any soil found in excavation work will be suitable and acceptable as backfill material.

3.2 MATERIAL HANDLING

- A. When backfill material is obtained from either commercial or non-commercial borrow pit, open pit to expose vertical faces of various strata for identification and selection of approved material to be used. Excavate selected material by vertical cuts extending through exposed strata to achieve uniformity in product.
- B. Establish temporary stockpile locations for practical material handling, control, and verification testing by Engineer in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.
- C. When stockpiling backfill material near project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering drainage system.
- D. Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

3.3 FIELD QUALITY CONTROL

A. Quality Control

1. The Engineer may sample and test backfill at:
 - a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.
 - b. On-site stockpiles.
 - c. Materials placed in Work.
2. The Engineer may re-sample material at any stage of work or location if changes in characteristics are apparent.

- B. Production Verification Testing: Authority's testing laboratory will provide verification testing on backfill materials, as directed by Engineer. Samples may be taken at source or at production plant, as applicable.

END OF SECTION

Section 02321

CEMENT STABILIZED SAND

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Cement stabilized sand.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for work performed under this Section. Include cost of such work in Contract unit prices for items listed in bid form requiring cement stabilized sand.
 - 2. Refer to Paragraph 3.4 for material credit.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 33 - Standard Specification for Concrete Aggregates (Fine Aggregate).
- B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. ASTM C 42 - Standard Test Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- D. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- E. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.
- F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. ASTM C 150 - Specification for Portland Cement.

- H. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil Cement-Mixtures.
- I. ASTM D 1632 - Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
- J. ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
- K. ASTM D 2487 - Standard Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- L. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- M. ASTM D 3665 - Standard Practice for Random Sampling of Construction Materials.
- N. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed target cement content and production data for sand-cement mixture in accordance with requirements of Paragraph 2.3, Materials Qualifications.

1.5 DESIGN REQUIREMENTS

- A. Use sand-cement mixture producing minimum unconfined compressive strength of 100 pounds per square inch (psi) in 48 hours.
 - 1. Design will be based on strength specimens molded in accordance with ASTM D 558 at moisture content within 3 percent of optimum and within 4 hours of batching.
 - 2. Determine minimum cement content from production data and statistical history. Provide no less than 1.1 sacks of cement per ton of dry sand.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cement: Type I Portland cement conforming to ASTM C 150.

- B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C 33, or requirements for bank run sand of Section 02320 - Utility Backfill Materials, and the following requirements:
 - 1. Classified as SW, SP, SW-SM, SP-SM, or SM by Unified Soil Classification System of ASTM D 2487.
 - 2. Deleterious materials:
 - a. Clay lumps, ASTM C 142 - less than 0.5 percent.
 - b. Lightweight pieces, ASTM C 123; less than 5.0 percent.
 - c. Organic impurities, ASTM C 40, color no darker than standard color.
 - 3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.
- C. Water: Potable water, free of oils, acids, alkalis, organic matter or other deleterious substances, meeting requirements of ASTM C 94.

2.2 MIXING MATERIALS

- A. Add required amount of water and mix thoroughly in pugmill-type mixer.
- B. Stamp batch ticket at plant with time of loading. Reject material not placed and compacted within 4 hours after mixing.

2.3 MATERIAL QUALIFICATION

- A. Determine target cement content of material as follows:
 - 1. Obtain samples of sand-cement mixtures at production facility representing range of cement content consisting of at least three points.
 - 2. Complete molding of samples within 4 hours after addition of water.
 - 3. Perform strength tests (average of two specimens) at 48 hours and 7 days.
 - 4. Perform cement content tests on each sample.
 - 5. Perform moisture content tests on each sample.
 - 6. Plot average 48-hour strength vs. cement content.
 - 7. Record scale calibration date, sample date, sample time, molding time, cement

feed dial settings, and silo pressure (if applicable).

- B. Test raw sand for following properties at point of entry into pug-mill:
 - 1. Gradation
 - 2. Plasticity index
 - 3. Organic impurities
 - 4. Clay lumps and friable particles
 - 5. Lightweight pieces
 - 6. Moisture content
 - 7. Classification
- C. Present data obtained in format similar to that provided in sample data form attached to this Section.
- D. The target content may be adjusted when statistical history so indicates. For determination of minimum product performance use formula:

$$f'_C + 1/2 \text{ standard deviation}$$

PART 3 EXECUTION

3.1 PLACING

- A. Place sand-cement mixture in maximum 12-inch-thick loose lifts and compact to 95 percent of maximum density as determined in accordance with ASTM D 558, unless otherwise specified. Refer to related specifications for thickness of lifts in other applications. Target moisture content during compaction is ± 3 percent of optimum. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at plant.
- B. Do not place or compact sand-cement mixture in standing or free water.
- C. Where potable water lines cross wastewater line, embed wastewater line with cement stabilized sand in accordance with Texas Administrative Code §290.44(e)(4)(B):
 - 1. Provide minimum of 10% cement per cubic yard of cement stabilized sand mixture, based on loose dry weight volume. Use at least 2.5 bags of cement per

cubic yard of mixture (2 sacks per ton of dry sand). Unless otherwise shown on Drawings, embed wastewater main or lateral minimum of six inches above and below.

2. Use brown coloring in cement stabilized sand for wastewater main or lateral bedding for identification of pressure rated wastewater mains during future construction.

3.2 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. One sample of cement stabilized sand shall be obtained for each 150 tons of material placed per day with no less than one sample per day of production. Random samples of delivered cement stabilized sand shall be taken in the field at point of delivery in accordance with ASTM 3665. Obtain three individual samples of approximately 12 to 15 lb each from the first, middle, and last third of the truck and composite them into one sample for test purpose.
- C. Prepare and mold four specimens (for each sample obtained) in accordance with ASTM D558, Method A, without adjusting moisture content. Samples will be molded at approximately same time material is being used, but no later than 4 hours after water is added to mix.
- D. After molding, specimens will be removed from molds and cured in accordance with ASTM D 1632.
- E. Specimens will be tested for compressive strength in accordance with ASTM D 1633, Method A. Two specimens will be tested at 48 hours plus or minus 2 hours and two specimens will be tested at 7 days plus or minus 4 hours.
- F. A strength test will be average of strengths of two specimens molded from same sample of material and tested at same age. Average daily strength will be average of strengths of all specimens molded during one day's production and tested at same age.
- G. Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D 1633 Section 9.
- H. Reporting: Test reports shall contain, as a minimum, the following information:
 1. Supplier and plant number
 2. Time material was batched
 3. Time material was sampled
 4. Test age (exact hours)

5. Average 48-hour strength
6. Average 7-day strength
7. Specification section number
8. Indication of compliance /non-compliance
9. Mixture identification
10. Truck and ticket numbers
11. The time of molding
12. Moisture content at time of molding
13. Required strength
14. Test method designations
15. Compressive strength data as required by ASTM D 1633
16. Supplier mixture identification
17. Specimen diameter and height, in.
18. Specimen cross-sectional area, sq. in.

3.3 ACCEPTANCE

- A. Strength level of material will be considered satisfactory if:
 1. The average 48-hour strength is greater than 100 psi with no individual strength test below 70 psi.
 2. All 7-day individual strength tests (average of two specimens) are greater than or equal to 100 psi.
- B. Material will be considered deficient when 7-day individual strength test (average of two specimens) is less than 100 psi but greater than 70 psi. See Paragraph 3.4 Adjustment for Deficient Strength.
- C. The material will be considered unacceptable and subject to removal and replacement at Contractor's expense when individual strength test (average of two specimens) has 7-day strength less than 70 psi.
- D. When moving average of three daily 48-hour averages falls below 100 psi, discontinue shipment to project until plant is capable of producing material, which exceeds 100 psi at 48 hours. Five 48-hour strength tests shall be made in this determination with no individual strength tests less than 100 psi.
- E. Testing laboratory shall notify Contractor, Engineer, and material supplier by email of tests indicating results falling below specified strength requirements within 24 hours.
- F. If any strength test of laboratory cured specimens falls below the specified strength,

Contractor may, at his own expense, request test of cores drilled from the area in question in accordance with ASTM C42. In such cases, three (3) cores shall be taken for

each strength test that falls below the values given in 3.03.A.

- G. Cement stabilized sand in an area represented by core tests shall be considered satisfactory if the average of three (3) cores is equal to at least 100 psi and if no single core is less than 70 psi. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted.

3.4 ADJUSTMENT FOR DEFICIENT STRENGTH

- A. When mixture produces 7-day compressive strength greater than or equal to 100 psi, then material will be considered satisfactory and bid price will be paid in full.
- B. When mixture produces 7-day compressive strength less than 100 psi and greater than or equal to 70 psi, material shall be accepted contingent on credit in payment. Compute credit by the following formula:

$$\text{Credit per Cubic Yard} = \frac{\$30.00 \times 2 (100 \text{ psi} - \text{Actual psi})}{100}$$

- C. When mixture produces 7-day compressive strength less than 70 pounds per square inch, then remove and replace cement-sand mixture and paving and other necessary work at no cost to Authority.

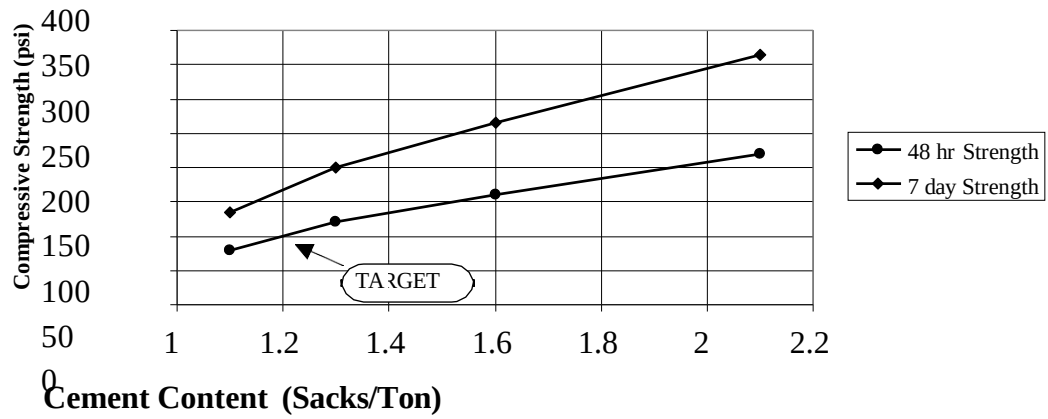
Supplier: COH Stabilized Sand	Plant No: 1 - Main Street	Date of Tests: January 1, 1997

Item	Raw Sand	1.1 Sack	100 psi	1.5	2.0
Moisture Content	10.9	15.7	4.0	13.8	13.7
Cement Feed Dial Setting	--	2.25	2.5	2.75	3.75
Silo Pressure (psi)	--	4	4	4	4
Batch Time	10:00	10:10	10:15	10:20	10:25
Sample Time	--	10:10	10:15	10:20	10:25
Molding Time	--	12:30	12:45	1:00	1:15
Cement Content (sacks/ton)	--	1.1	1.3	1.6	2.1
Compressive Strength at 48 hrs (avg of 2)	--	80	120	160	220
Compressive Strength at 7 days (avg of 2)	--	135	200	265	365

Sieve size	Percent Passing	COH & Authority Spec. Section 02320
3/8 Inch	100	--
No. 16	100	--
No. 40	100	--
No. 50	99	--
No. 100	41	--
No. 200	11	0 to 15

Raw Sand Tests	Result	COH & Authority Spec. Section 02320
<i>Plasticity Index</i>	Non-Plastic	4 Maximum
<i>Organic Impurities</i>	Passing	No Darker Than Standard Color for ASTM C40
<i>Clay Lumps & Friable Parts (%)</i>	0.0	0.5 % Maximum
<i>Lightweight Pieces (%)</i>	0.0	5.0 % Maximum
<i>Classification</i>	SP-SM	SW, SP, SW-SM, SP-SM, SM

Compressive Strength vs Cement Content



END OF SECTION

Section 02322

FLOWABLE FILL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Flowable Fill for furnishing, mixing, transporting and placing flowable fill.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for flowable fill under this Section. Include cost in unit prices for work, as specified in Section 01270 – Measurement and Payment

1.3 REFERENCES

- A. ASTM C 31 – Making and Curing Concrete Test Specimens in the field.
- B. ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens.
- C. ASTM C 40 – Organic Impurities in Fine Aggregates for Concrete.
- D. ASTM C 94 - Ready-Mixed Concrete.
- E. ASTM C 150 - Portland Cement.
- F. ASTM C 192 – Making and Curing Concrete Test Specimens in the Laboratory.
- G. ASTM C 260 – Air-Entraining Admixtures for Concrete.
- H. ASTM C 494 - Chemical Admixtures for Concrete.
- I. ASTM C 618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Concrete.
- J. ASTM C 4318 – Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

- B. Submit proposed mix design
- C. Submit a copy of delivery tickets accompanied by batch tickets, providing the information required by ASTM C 94 to Engineer in the field at time of delivery.

PART 2 P R O D U C T S

2.1 GENERAL

- A. Provide material conforming to:
 - 1. Cement- ASTM C 150, Type I.
 - 2. Fly Ash – ASTM C 618, Class C, with a minimum CaO content of 20 percent.
 - 3. Water- ASTM C 94.
 - 4. Fine Aggregate – Natural or manufactured fine aggregate, or a combination thereof, free from deleterious amounts of salt, alkali, vegetable matter or other objectionable material. The plasticity index shall be 4 or less when tested in accordance with ASTM D 4318. Organic impurities, when tested in accordance with ASTM C 40, shall not show a color darker than the standard color. It is intended that the fine aggregate be fine enough to stay in suspension in the mortar to the extent required for proper flow. The fine aggregate shall conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 200	0-10

If flowable mixture cannot be produced, the fine aggregate may not be approved.

- 5. Admixtures – ASTM C 260 and /or C 494.

2.2 MIX DESIGN

- A. Mix design shall state the following information:
 - 1. Mix design number or code designation to order the concrete from the supplier.
 - 2. Design strength at 7 days (unless otherwise noted on the Plans).
 - 3. Cement type and brand.
 - 4. Fly ash type and brand.

- 5. Admixtures type and brand.
- 6. Proportions of each material used.
- B. Minimum strength requirement is 100 psi in 7 days unless otherwise noted on the Plans.

PART 3 E X E C U T I O N

3.1 BATCHING, MIXING AND TRANSPORTATION

- A. Batch, mix and transport flowable fill in accordance with ASTM C 94, except when directed otherwise by the Engineer.
- B. Mix flowable fill in quantities required for immediate use. Do not use portions which have developed initial set or which are not in place within 90 minutes after the initial water has been added.
- C. Do not mix flowable fill while the air temperature is at or below 35 degrees F. without prior approval of the Engineer.

3.2 PLACEMENT

- A. Seal off the area to be repaired.
- B. Monitor and control the fluid pressure during placement of flowable fill prior to set. Take appropriate measures to avoid excessive pressure that may damage or displace structures or cause flotation. Cease operations if flowable fill is observed leaking from the repair area. Repair or replace damaged or displaced structures at no additional cost.

3.3 TESTING AND INSPECTION

- A. Refer to Section 01454 – Testing Laboratory Inspection.

3.4 CLEAN UP

- A. Clean up excess flowable fill discharged from the work area and remove excess flowable fill from pipes at no additional cost.
- B. Refer to Section 01576 – Waste Material Disposal.

END OF SECTION

Section 02330

EMBANKMENT

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Construction of embankments with excess excavated material and borrow.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for embankment under this section. Include payment in unit price for excavation or borrow.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- B. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- C. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Refer to Section 02315 - Roadway Excavation for acceptable excess materials from roadway excavation.
- B. Refer to Section 02317 - Excavation and Backfill for Utilities for acceptable excess materials from utility excavation and trenching.

- C. Refer to Section 02319 - Borrow for acceptable borrow materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify borrow and excess excavated materials to be reused are approved.
- B. Verify removals and clearing and grubbing operations have been completed.

3.2 PREPARATION

- A. Backfill test pits, stump holes, small swales and other surface irregularities. Backfill and compact in designated lift depths to requirements for embankment compaction.
- B. Record location and plug and fill inactive water and oil wells. Conform to Texas State Health Department, Texas Commission on Environmental Quality and Texas Railroad Commission requirements. Notify Engineer prior to plugging wells.
- C. Excavate and dispose of unsuitable soil and other unsuitable materials which will not consolidate. Backfill and compact to requirements for embankment. Unsuitable soil is defined in Section 02316 - Excavation and Backfill for Structures and Section 02320 - Utility Backfill Materials.
- D. Backfill new utilities below future grade. Conform to requirements of Sections 02317 - Excavation and Backfill for Utilities, 02511 - Water Lines, 02531 - Gravity Sanitary Sewers, and 02532 - Sanitary Sewage Force Mains.

3.3 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other features outside of embankment limits.
- B. Protect utilities above and below grade, which are to remain.
- C. Conform to protection requirements of Section 02315 - Roadway Excavation.

3.4 PLACING EMBANKMENT

- A. Do not conduct placement operations during inclement weather or when

existing ground or fill materials exceed 3 percent of optimum moisture content. Contractor may manipulate wet material to facilitate drying, by disking or windrowing.

- B. Do not place embankment fill until density and moisture content of previously placed material comply with specified requirements.
- C. Scarify areas to be filled to minimum depth of 4 inches to bond existing and new materials. Mix with first fill layer.
- D. Spread fill material evenly, from dumped piles or windrows, into horizontal layers approximately parallel to finished grade. Place to meet specified compacted thickness. Break clods and lumps and mix materials by blading, harrowing, disking or other approved method. Extend each layer across full width of fill.
- E. Each layer shall be homogeneous and contain uniform moisture content before compaction. Mix dissimilar abutting materials to prevent abrupt changes in composition of fill.
- F. Layers shall not exceed the following compacted thickness:
 - 1. Areas indicated to be under future paving or shoulders, to be constructed within 6 months: 6 inches when compacted with pneumatic rollers, or 8 inches when compacted with other rollers.
 - 2. Other areas: 12 inches
- G. For steep slopes, cut benches into slope and scarify before placing fill. Place increasingly wider horizontal layers of specified depth to level of each bench.
- H. Build embankment layers on back slopes, adjacent to existing roadbeds, to level of old roadbed. Scarify top of old roadbed to minimum depth of 4 inches and recompact with next fill layer.
- I. Construct to lines and grades shown on Drawings.
- J. Remove unsuitable material and excess soil not being used for embankment from site in accordance with requirements of Section 01576 - Waste Material Disposal.
- K. Maintain moisture content of embankment materials to attain required density.
- L. Compact to following minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on Drawings:

1. Areas under future paving and shoulders: Minimum density of 95 percent of maximum dry density.
2. Other areas: Minimum density of 90 percent of maximum dry density.

3.5 TOLERANCES

- A. Top of compacted surface: Plus or minus 1/2 inch in cross section or 16 foot length.

3.6 FIELD QUALITY CONTROL

- A. Compaction Testing will be performed in accordance with ASTM D 698 or ASTM D 2922 and ASTM D 3017 under provisions of Section 01454 - Testing Laboratory Services.
- B. A minimum of three tests will be taken for each 1000 linear feet per lane of roadway or 500 square yards of embankment per lift.
- C. If tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at no cost to Authority.

END OF SECTION

Section 02336

LIME STABILIZED SUBGRADE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Foundation course of lime stabilized subgrade material.
 - 1. Application of lime slurry to subgrade.
 - 2. Mixing, compaction, and curing of lime slurry, water, and subgrade into a stabilized foundation.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Measurement and payment for lime stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement will be made for each required thickness of subgrade course.
 - a. Limits of measurement shall match actual pavement replaced, but no greater than maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed lime stabilized subgrade material that extends 2 foot beyond outside edge of pavement to be replaced, except where proposed pavement section shares common longitudinal or transverse edge with existing pavement section. No payment will be made for lime stabilized subgrade in areas beyond these limits.
 - b. Limits of measurement and payment shall match pavement replacement limits shown on Drawings, except as noted in Paragraph 1.2.A.1.a, or as approved by Engineer.
 - 2. Measurement and payment for lime is by ton of 2000 pounds dry weight basis. Calculate weight of dry solids for lime slurry based on percentage by dry weight solids.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

1.3 Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment

for Work in this Section is included in total Stipulated Price.

1.4 DEFINITION

- A. Moist Cure: Curing soil and lime to obtain optimum hydration.
- B. 1000-Foot Roadway Section: 1000 feet per lane width or approximately 500 square yards of compacted subgrade for other than full-lane-width roadway sections.

1.5 REFERENCES

- A. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
- B. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- C. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- D. TxDOT Tex-101-E (Part III) - Preparation of Soil and Flexible Base Material for Testing.
- E. TxDOT Tex-140-E - Measuring Thickness of Pavement Layer.
- F. TxDOT Tex-600-J - Sampling and Testing Hydrated Lime, Quicklime, and Commercial Lime Slurry.

1.6 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification that hydrated lime, quicklime, or commercial lime slurry complies with specifications.
- C. Submit weight tickets, certified by supplier, with each bulk delivery of lime to work site.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Bagged lime shall bear manufacturer's name, product identification, and certified weight. Bags varying more than 5 percent of certified weight may be rejected; average weight of 50 random bags in each shipment shall not be less than certified weight.

- B. Store lime in weatherproof enclosures. Protect lime from ground dampness.

PART 2 PRODUCTS

2.1 WATER

- A. Use clean, clear water, free from oil, acids, alkali, or vegetation.

2.2 LIME

- A. Type A - Hydrated Lime: Dry material consisting essentially of calcium hydroxide or mixture of calcium hydroxide and an allowable percentage of calcium oxide as listed in chemical composition chart.
- B. Type B - Commercial Lime Slurry: Liquid mixture consisting essentially of lime solids and water in slurry form. Water or liquid portion shall not contain dissolved material in sufficient quantity to be injurious or objectionable for purpose intended.
- C. Type C - Quicklime: Dry material consisting essentially of calcium oxide. Furnish quicklime in either of the following grades:
1. Grade DS: Pebble quicklime of gradation suitable for use in preparation of slurry for wet placing.
 2. Grade S: Finely-graded quicklime for use in preparation of slurry for wet placing. Do not use grade S quicklime for dry placing.
- D. Conform to the following requirements:

CHEMICAL COMPOSITION	TYPE		
	A	B	C
Active lime content, % by weight $\text{Ca(OH)}_2 + \text{CaO}$	90.0 min ¹	87.0 min ²	-
Unhydrated lime content, % by weight CaO	5.0 max	-	87.0 min
Free water content, % by weight H ₂ O:	5.0 max	-	-
SIZING			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max	0.2 max ²	8.0 max ³

CHEMICAL COMPOSITION	TYPE		
	A	B	C
No. 30	4.0 max	4.0 max ²	-
Dry sieve, as % by weight residue retained:			
1-inch	-	-	0.0
1/2-inch	-	-	10.0 max
Notes: 1. Maximum 5.0% by weight CaO shall be allowed in determining total active lime content. 2. Maximum solids content of slurry. 3. Total active lime content, as CaO, in material retained on No. 6 sieve shall not exceed 2.0% by weight of original Type C lime.			

E. Deliver lime slurry to job site as commercial lime, or prepare at job site by using hydrated lime or quicklime. Provide slurry free of liquids other than water and of consistency that can be handled and uniformly applied without difficulty.

F. Lime containing magnesium hydroxide is prohibited.

2.3 SOIL

A. Soil to receive lime treatment may include borrow or existing subgrade material, existing pavement structure, or combination of all three. Where existing pavement or base material is encountered, pulverized or scarify material so that 100 percent of sampled material passes 2- inch sieve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade will support imposed loads.
- B. Verify subgrade lines and grades.

3.2 PREPARATION

- A. Complete backfill of utilities prior to stabilization.
- B. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:

1. Cutters accurately provide smooth surface over entire width of cut to plane of secondary grade.
2. Provide cut to depth as specified or shown in the Drawings.
- C. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Obtain uniform stability.
- D. Correct wet or unstable material below secondary grade by scarifying, adding lime, and compacting as directed by Engineer.
- E. Pulverize existing material so that 100 percent passes a 1-3/4-inch sieve.

3.3 LIME SLURRY APPLICATION

- A. Apply slurry with distributor truck equipped with an agitator to keep lime and water in consistent mixture. Make successive passes over measured section of roadway to attain proper moisture and lime content. Limit spreading to an area where preliminary mixing operations can be completed on same working day.
- B. Minimum lime content shall be 5 percent of dry unit weight of subgrade as determined by ASTM D 698.

3.4 PRELIMINARY MIXING

- A. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime, and water to required depth. Obtain homogeneous friable mixture free of clods and lumps.
- B. Shape mixed subgrade to final lines and grades.
- C. Eliminate following operations and final mixing if pulverization requirements of Paragraph 3.5C can be met during preliminary mixing:
 1. Seal subgrade as precaution against heavy rainfall by rolling lightly with light pneumatic rollers.
 2. Cure soil lime material for 24 to 72 hours or as required to obtain optimum hydration. Keep subgrade moist during cure.

3.5 FINAL MIXING

- A. Use approved single-pass or multiple-pass rotary speed mixers to uniformly mix cured soil and lime to required depth.
- B. Add water to bring moisture content of soil mixture to optimum or above.

- C. Mix and pulverize until all material passes 1-3/4-inch sieve; minimum of 85 percent, excluding non-slacking fractions, passes 3/4-inch sieve; and minimum of 60 percent excluding non-slacking fractions passes No. 4 sieve. Test according to TxDOT Tex-101-E, Part III using dry method.
- D. Shape mixed subgrade to final lines and grades.
- E. Do not expose hydrated lime to open air for 6 hours or more during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

3.6 COMPACTION

- A. Aerate or sprinkle to attain optimum moisture content to 3 percent above optimum, as determined by ASTM D 698 on material sample from roadway after final mix with lime.
- B. Start compaction immediately after final mixing.
- C. Spread and compact in two or more equal layers where total compacted thickness is greater than equipment manufacturer's recommended range of mixing and compaction.
- D. Compact with approved heavy pneumatic or vibrating rollers, or combination of tamping rollers and light pneumatic rollers. Begin compaction at bottom and continue until entire depth is uniformly compacted.
- E. Do not allow stabilized subgrade to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and recompacting.
- F. Compact subgrade to minimum density of 95 percent of maximum dry density, according to ASTM D 698, at moisture content of optimum to 3 percent above optimum, unless otherwise indicated on Drawings:
- G. Seal with approved light pneumatic tired rollers. Prevent surface hair line cracking. Rework and recompact at areas where hairline cracking develops.

3.7 CURING

- A. Moist cure for minimum of 3 days before placing base or surface course, or opening to traffic. Subgrade may be opened to traffic after 2 days when adequate strength has been attained to prevent damage. Restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons.
- B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to

keep surface knit together.

- C. Place base or surface within 14 days after final mixing and compaction. Restart compaction and moisture content of base material when time is exceeded.

3.8 TOLERANCES

- A. Completed surface: smooth and conforming to typical section and established lines and grades.
- B. Top of compacted surface: Plus or minus 1/4 inch in cross section or in 16-foot length.
- C. Depth of lime stabilization shall be plus or minus one inch of specified depth for each 1000- foot roadway section.

3.9 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Test soils, lime, and mixtures as follows:
 - 1. Tests and analysis of soil materials will be performed in accordance with ASTM D 4318, using the wet preparation method.
 - 2. Sampling and testing of lime slurry shall be in accordance with TxDOT Tex-600-J, except using a lime slurry cup.
 - 3. Sample mixtures of hydrated lime or quicklime in slurry form will be tested to establish compliance with specifications.
 - 4. Moisture-density relationship will be established on material sampled from roadway, after stabilization with lime and final mixing, in accordance with ASTM 698, Moist preparation Method.
- C. In-place depth will be evaluated for each 1000-foot roadway section and determined in accordance with TxDOT Tex-140-E in hand excavated holes. For each 1000-foot section, 3 phenolphthalein tests will be performed. Average stabilization depth for 1000-foot section will be based on average depth for three tests.
- D. Perform compaction testing in accordance with ASTM D 2922. Three tests will be performed for each 1000-foot roadway section.
- E. Pulverization analysis will be performed as required by Paragraph 3.5C on material

sampled during mixing of each production area. Three tests will be performed per 1000-foot roadway section or a minimum of once daily.

3.10 REWORK OF FAILED SECTIONS

- A. Rework sections that do not meet specified thickness.
- B. Perform the following steps when more than 72 hours have lapsed since completion of compaction.
 - 1. Moist cure for minimum of 3 days after compaction to required density.
 - 2. Add lime at rate of 25 percent of specified rate at no additional cost to Authority.
 - 3. Moisture density test of reworked material must be completed by laboratory before field compaction testing can be completed.

3.11 PROTECTION

- A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course. Protect asphalt membrane from being picked up by traffic.
- B. Repair defects immediately by replacing material to full depth.

END OF SECTION

Section 02337

LIME/FLY ASH STABILIZED SUBGRADE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Foundation course of lime/fly ash stabilized subgrade material.
 - 1. Application of lime slurry and fly ash to subgrade
 - 2. Mixing, compaction, and curing of lime, slurry, fly ash, water and subgrade into a stabilized foundation

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Measurement and payment for lime/fly ash stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement will be made for each required thickness of subgrade course.
 - a. Limits of measurement shall match actual pavement replaced, but no greater than the maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed lime/fly ash stabilized subgrade material that extends 2 foot beyond outside edge of pavement to be replaced, except where proposed pavement section shares a common longitudinal or transverse edge with existing pavement section. No payment will be made for lime/fly ash stabilized subgrade in areas beyond these limits.
 - b. Limits of measurement and payment shall match pavement replacement limits shown on Drawings, except as noted in Paragraph 1.2.A.1.a, or as approved by Engineer
 - 2. Payment for hydrated lime and quicklime is by ton of 2000 pounds dry-weight basis
 - 3. Payment for commercial lime slurry is by ton of 2000 pounds of lime calculated on percentage by weight of dry solids for grade of slurry

- 4. Payment for fly ash is on unit price basis per ton
- 5. Refer to Section 01270 - Measurement and Payment for unit price procedures

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 DEFINITIONS

- A. Moist Cure: Curing soil lime/fly ash material to obtain optimum hydration.
- B. 1000-Foot Roadway Section: 1000 feet per lane width or approximately 500 square yards of compacted subgrade for other than full-lane-width roadway sections.

1.4 REFERENCES

- A. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcinated Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification that fly ash, hydrated lime, quicklime, or commercial lime slurry complies with these specifications.
- C. Submit weight tickets, certified by supplier, with each bulk delivery of materials to work site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Conform to requirements of Section 02336 - Lime Stabilized Subgrade.
- B. Quicklime can be dangerous; exercise extreme caution if used for Work. Become informed about recommended precautions in handling, storage and use of quicklime.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Water: clean, clear and free from oil, acids, alkali, or vegetable matter.
- B. Conform to requirements of Section 02336 - Lime Stabilized Subgrade for Type

A hydrated lime, Type C quicklime, and Type B commercial lime slurry.

- C. Fly ash: Residue or ash remaining after burning finely pulverized coal at high temperatures conforming to requirements of ASTM C 618, Type ‘C’ or ‘F’ and following:
 - 1. Minimum CaO content of 20 percent
 - 2. Loss on ignition not to exceed 3 percent
 - 3. Contain no lignite ash
- D. Asphaltic Seal Cure: Conform to requirements of Section 02336 - Lime Stabilized Subgrade.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Conform to Part 3 of Section 02336 - Lime Stabilized Subgrade with following exceptions:
 - 1. Include fly ash in percentage amounts in lime or lime slurry as established from geotechnical evaluation for application, mixing, and compaction.
 - 2. Apply lime/fly ash as single mix, single pass over lower PI soils.
 - 3. Conduct operations to minimize elapsed time between mixing and compacting lime/fly ash stabilized subgrade in order to take advantage of rapid initial set characteristics. Complete compaction within 2 hours of commencing compaction and not more than 6 hours after adding and mixing last stabilizing agent.

3.2 QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Soil will be sampled to establish percent of fly ash and hydrated lime, quicklime, or lime slurry to be applied to subgrade material.
- C. Testing will be in accordance with Part 3 of Section 02336-Lime-Stabilized Subgrade.

END OF SECTION

Section 02338

PORTLAND CEMENT STABILIZED SUBGRADE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Foundation course of portland cement stabilized natural subgrade material.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for Portland cement stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement will be made for each different required thickness of subgrade course.
 - a. Limits of measurement shall match actual pavement replaced, but no greater than maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed portland cement stabilized subgrade material that extends 2 foot beyond outside edge of pavement to be replaced, except where proposed pavement section shares common longitudinal or transverse edge with existing pavement section. No payment will be made for portland cement stabilized subgrade in areas beyond these limits.
 - b. Limits of measurement and payment shall match pavement replacement limits shown on Drawings, except as noted in Paragraph 1.2.A.1.a, or as approved by Engineer.

2. Payment for Portland cement is by ton of 2000 pounds dry-weight basis.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 150 - Standard Specification for Portland Cement.
- B. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil-Cement- Mixtures.

- C. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft³).
- D. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification that Portland cement complies with these specifications.

PART 2 P R O D U C T S

2.1 WATER

- A. Water: clean, clear and free from oil, acids, alkali, or organic matter.

2.2 PORTLAND CEMENT

- A. ASTM C 150 Type I; bulk or sacked.

2.3 SOIL

- A. Provide soil consisting of approved material free from vegetation or other objectionable matter encountered in existing roadbed.

2.4 TESTS

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Tests and analysis of soil materials will be performed in accordance with ASTM D 4318.
- C. Soil will be evaluated to establish ratio of cement to soil to obtain desired stability. Normal range is 6 percent to 10 percent by weight.
- D. The percentage of moisture in soil, at time of cement application, will be determined by ASTM D 558. Moisture will not be allowed to exceed quantity that will permit uniform, complete mixture of soil and cement during dry mixing operations nor specified optimum moisture content for soil cement mixture, as

determined.

PART 3 E X E C U T I O N

3.1 EXAMINATION

- A. Verify compacted subgrade is ready to support imposed loads.
- B. Verify subgrade lines and grades are correct.

3.2 EQUIPMENT

- A. Apply Portland cement treatment with machine or combination of machines and auxiliary equipment to produce specified results. Mixing may be accomplished by multiple-pass traveling mixing plant or single-pass traveling mixing plant. Provide sufficient equipment to enable continuous prosecution of work

3.3 PREPARATION

- A. Backfill for utilities below future grade.
- B. Verify subgrade is firm and able to support, without displacement, construction equipment at specified density. Correct soft or yielding subgrade and stabilize by scarifying and aerating or by adding cement and compacting to uniform stability.
- C. Grade, shape, and compact, as required, to allow construction of Portland cement treatment for in-place materials to lines, grades, thickness, and typical cross section shown on Drawings. Remove unsuitable soil or material and replace with acceptable material.
- D. Pulverize soil so that at completion of moist-mixing, 100 percent by dry weight passes 1-inch sieve, and minimum of 80 percent passes No. 4 sieve, exclusive of gravel or stone retained on these sieves. Pulverize existing bituminous wearing surfaces so that 100 percent will pass 2-inch sieve.

3.4 MIXING

- A. Do not place and mix cement when temperature is below 40 degrees F and falling. Place base when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.
- B. Spread cement uniformly on soil at rate specified by laboratory. When bulk cement spreader is used, position it by string lines or other approved method to ensure uniform distribution of cement. Apply cement only to area where operations can be continuous and completed in daylight, within 1 hour of

application. Amount of moisture in soil at time of cement placement shall not exceed quantity that will permit uniform mixture of soil and cement during dry mixing operations. Do not exceed specified optimum moisture content for soil cement mixture.

- C. Do not allow equipment other than that used in spreading and mixing, to pass over freshly spread cement until it is mixed with soil.
- D. Dry mix cement with soil after cement application. Continue mixing until cement has been sufficiently blended with soil to prevent formation of cement balls when water is applied. Mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.
- E. Immediately after dry mixing is complete, uniformly apply water as necessary and incorporate it into mixture. Pressurized equipment must provide adequate supply to ensure continuous application of required amount of water to sections being processed within 3 hours of cement application. Ensure proper moisture distribution at all times. After last increment of water has been added, continue mixing until thorough and uniform mix has been obtained.
- F. Ensure percentage of moisture in mixture, based on dry weights, is within 2 percentage points of specified optimum moisture content prior to compaction. When uncompacted soil cement mixture is wetted by rain indicating that average moisture content exceeds tolerance given at time of final compaction, reconstruct entire section in accordance with this Section at no additional cost to Authority.

3.5 COMPACTION

- A. Prior to beginning compaction, ensure mixture is in loose condition for its full depth. Uniformly compact the loose mixture to specified density, lines, and grades.
- B. After soil and cement mixture is compacted, apply water uniformly as needed and mix thoroughly. Then reshape surface to required lines, grades, and cross section and lightly scarify to loosen imprints left by compacting or shaping equipment.
- C. Roll resulting surface with pneumatic-tired roller and "skin" surface with power grader. Thoroughly compact mixture with pneumatic roller, adding small increments of moisture, as needed. When aggregate larger than No. 4 sieve is present in mixture, make one complete coverage of section with flat-wheel roller immediately after skinning operation. When approved by Engineer, surface finishing methods may be varied from this procedure, provided dense uniform surface, free of surface compaction planes, is produced. Maintain moisture content of surface material at its specified optimum during finishing operations.

Compact and finish surface within period not to exceed 2 hours, to produce smooth, closely knit surface, free of cracks, ridges, or loose material, conforming to crown, grade, and line shown on Drawings within period not to exceed 2-hours.

3.6 CONSTRUCTION JOINTS

- A. At end of each day's construction, form straight transverse construction joint by cutting back into total width of completed work to form true 2-inch depth vertical face free of loose and shattered material. Construct cement treatment for large wide areas in series of parallel lanes of convenient length and width approved in advance by Engineer.

3.7 CURING

- A. Moist cure for minimum of 3 days before placing base or surface course, or opening to traffic. When open, restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons.
- B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.
- C. Place base and surface within 14 days after final mixing and compaction, unless prior approval is obtained from Engineer.

3.8 TOLERANCES

- A. Completed surface: smooth and conforming to typical section and established lines and grades.
- B. Top of compacted surface: Plus or minus 1/4 inch in cross section or in 16-foot length.

3.9 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. In-place density will be determined in accordance with ASTM D 2922 or ASTM D 698. Minimum of three tests will be taken for each 1000 feet per lane of roadway or 500 square yards of embankment.

3.10 PROTECTION

- A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course.

- B. Repair defects immediately by replacing material to full depth.

END OF SECTION

Section 02371 (Large Diameter)
EROSION CONTROL AND VEGETATION MAT

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Installation of erosion control and vegetation mat for newly seeded and fertilized slope areas.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for erosion control and vegetation mat. Include cost in unit price for regrading existing ditches and slopes.

1.03 REFERENCES

- A. ASTM D6475 – Mass per Unit Area
- B. ASTM D6818 – Tensile Strength, Elongation
- C. ASTM D6525 – Thickness
- D. ASTM D6567 – Light Penetration
- E. ASTM D1117 - Water Absorption

1.04 DESCRIPTION

- A. Mat shall cover newly seeded and fertilized ground, and shall be held in place with netting and staples driven into ground. Mat shall be installed per manufacturer's instructions unless specifically directed otherwise by the project plans or specifications.
- B. Mat shall promote germination of grass seedlings and protect seedlings and establish vegetation.
- C. Mat shall be specifically designed for use on steep slopes and other hard-to-hold problem areas.
- D. Mat shall help ground retain moisture, control surface temperature fluctuations of soil, conform to terrain, protect seedlings against sun burnout, and break up raindrops to prevent erosion.
- E. Wood fibers of blanket ultimately shall attach to soil, stabilize terrain, and act as mulch after vegetation has started.
- F. Netting shall degrade by time in sunlight.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit complete product data for erosion control mat. Indicate conformance to appropriate reference standards.

- C. Submit product sample no smaller than 4-inches square and no larger than 8-inches square contained in a sealed plastic bag. Bag shall be labeled with product name and project specification number.
- D. Submit AASHTO NTPEP Test Report.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Erosion Blanket:
 - 1. Machine produced mat consisting of 100 percent wood with 80 percent 6-inch or longer fiber length, with consistent thickness and fiber evenly distributed over entire area of blanket.
 - 2. Topside of blanket shall be covered with 3/4-inch by 3/4-inch mesh of biodegradable netting.
 - 3. Blanket shall be made smolder-resistant with use of chemical additives.
 - 4. Matting shall be natural colored. Artificial coloring of the wood fibers will not be permitted.
- B. Staples:
 - 1. 11-gauge biodegradable steel.
 - 2. "U" shaped with legs 6 inches in length and 1-inch crown.

2.02 ACCEPTABLE PRODUCT

- A. Standard Excelsior Erosion Control Blanket; Erosion Control Systems, Inc, Western Excelsior Corp., or approved equal.

PART 3 E X E C U T I O N

3.01 PREPARATION

- A. Properly cultivate, seed and fertilize area to be covered in compliance with Section 02921 - Hydromulch Seeding and Harris County Specification No. 165 where applicable.
- B. Apply blanket immediately over prepared ground. Do not walk on prepared ground prior to installation of blanket.

3.02 APPLICATION

- A. Unroll blanket over prepared area; keep netting on top and fibers in contact with soil over entire area.
- B. Apply blankets in ditches in direction of water flow, with overlapping edges, downstream edge on top of the following blanket.

- C. Butt edges snugly (overlap maximum 2 inches) and fasten to ground with staples driven into ground.
- D. Engage portion of netting with staple and set flush with soil surface.
- E. Use average of 1 to 1-1/2 staples per yard and maximum of 1-1/2 feet distance between staples at ends. Follow stapling procedure as recommended by manufacturer.
- F. Individual blanket size: 7.5 feet by 96 feet (80 square yards) with weight of 68 pounds plus or minus 1 pound.

3.03 STORAGE

- A. Product shall be stored in a cool, dark, dry location to prohibit degradation of the product prior to installation.
- B. Product shall be free of dirt, debris, weeds, and other foreign materials upon installation.

END OF SECTION

Section 02425 (Large Diameter)

TUNNEL EXCAVATION AND PRIMARY LINER FOR WATER MAINS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Tunnel construction operation with primary lined tunnel installed during tunnel drive followed by placement of water line inside tunnel after completion of tunnel construction. This Specification is intended to be primarily functional in nature and to define in general terms work to be accomplished. Contractor granted full discretion to select method of tunnel construction, subject to review by Engineer.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for other work performed under this Specification such as excavation, liner, grouting, instrumentation, or pavement restoration, including pressure jacking or other means of raising settled pavement. Include cost of such other work in contract unit prices for items listed in bid form for Section 02517 – Water Line in Tunnels.
- B. Where such effort is necessary, cost for ground water control during course of tunnel work included in unit prices for water main in tunnel.
- C. Ground water control required during course of Project to lower water table for other utility installation, to remove standing water, surface drainage seepage, or to protect ongoing work against rising waters or floods considered incidental to work being performed.

1.03 REFERENCE STANDARDS

- A. The publications listed below form part of this specification to extent referenced. Publications are referred to in text by abbreviations only.
 - 1. AREMA Manual for Railway Engineering (Applicable sections).
 - 2. American Association of State Highway and Transportation Officials (AASHTO).
 - 3. American Society for Testing and Materials (ASTM).
 - a. ASTM A36 - Standard Specifications for Carbon Structural Steel.
 - b. ASTM A82 - Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.

- c. ASTM A185 - Standard Specifications for Steel Welded Wire Fabric for Concrete Reinforcement.
 - d. ASTM A283 - Standard Specifications for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - e. ASTM A307 - Standard Specifications for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - f. ASTM A328 - Standard Specifications for Steel Sheet Piling.
 - g. ASTM A496 - Standard Specifications for Steel Wire, Deformed, for Concrete Reinforcement.
 - h. ASTM A615 - Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - i. ASTM C33 - Standard Specification for Concrete Aggregates.
 - j. ASTM C150 - Standard Specifications for Portland Cement.
 - k. ASTM C1433 - Standard Specifications for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
4. American Water Works Association (AWWA)
- a. AWWA C200 - Steel Water Pipe 6-inches and Larger.
5. Occupational Safety and Health Administration (OSHA): Particular attention is called to Subpart S of OSHA Standards (29 CFR 1926/1920), published as U.S. Department of Labor Publication 2207, Revised Oct. 1, 1979. Second revision dated August 1, 1989. See Federal Register dated June 2, 1989 for revised standard and commentary.

1.04 DEFINITION

- A. Tunneling Work Plan defined as written description together with sketches, drawings, schedules, and other documents defining Contractor's planned methods and procedures to construct referenced item. Contractor's Construction Drawings defined as drawings by which Contractor proposes to furnish, construct, install, and operate referenced item. Submission of Tunneling Work Plans, including construction drawings, required for providing Engineer sufficient details to verify that Contractor's planned work and work in progress is in accordance with intent of design and specification requirements.
- B. Primary Liner defined as Contractor's initial construction liner and tunnel support installed by Contractor for ground stability and safety during construction preparatory to installation of water line. Contractor chooses method of construction in accordance

with this Specification. Inclusion of various methods in specification or reviews by Engineer of Contractor's submittals shall not be construed by Contractor as endorsement by Engineer that all such methods are constructible or will work for specific subsurface soils encountered.

- C. Carrier Pipe is referred to as water line or permanent (secondary) liner. Such water line/permanent liner defined and installed in accordance with Section 02517 - Water Line in Tunnels or Section 02511 - Water Line.

1.05 SUBMITTALS

- A. Review: Conform to requirements of Section 01330 - Submittal Procedures. Engineer will review submitted plans, details and data for compliance with requirements of Specification. Such review shall not be construed to relieve Contractor of responsibilities under Contract. Contractor shall not commence work on items requiring Contractor's work plan, construction drawings or other submittals until submittals have been reviewed and accepted by Engineer. All structural designs and other engineered components signed and sealed by Professional Engineer registered in the State of Texas.
- B. Tunneling: Submit for review Tunneling Work Plan with complete construction drawings, complete written description identifying details of proposed method of construction and sequence of operations to be performed during construction, as required by method of tunnel excavation and liner installation. Sufficiently detail construction drawings and descriptions detailed to demonstrate to Engineer whether proposed materials and procedures will meet requirements of Specification.
 - 1. Depending on method of construction, submit Tunneling Work Plan and construction drawings on following items:
 - a. If use of mechanized excavating equipment (such as TBM or shielded excavators) is proposed, submit arrangement drawings and technical specifications of machine and trailing equipment (included modifications), experience record with this type of machine of both Contractor and proposed operator for machine.
 - b. A tunnel shield that is separate from mechanized excavation equipment or for use with hand excavation. Submit arrangement drawings, design criteria, dimensional data and method of excavation and operation of shield, including acceptable method for supporting, controlling and closing face of heading.
 - c. Complete details of equipment, methods and procedures to be used for ground support, including but not limited to primary liner installation, timing of installation in relation to excavation plan, bulkheads and equipment.

- d. Grouting techniques meeting requirements this Section and Section 02431 - Tunnel Grout.
 - e. Procedures for measuring excavation quantities versus forward progress during tunneling operation (for earth pressure balance TBM only).
 - f. Method of controlling line and grade of excavation.
 - g. Details of muck removal, including equipment type, number and disposal location.
 - h. Description of ventilation system, lighting system, and electrical system.
 - i. Proposed contingency plans for critical phases and areas of tunneling. Critical areas include, but are not limited to, the entire TxDOT right of way along the tunnel alignments. Contingency plan in TxDOT right of way must be submitted for approval to TxDOT.
 - j. Proposed plans for preventing loss of ground and settlement. Plans in the TxDOT right of way must be submitted for approval to TxDOT.
- 2. Submit for review design criteria established by Contractor's Engineer for primary liner, including design calculations and installation details.
 - 3. Include in Tunneling Work Plan special activities at critical utility crossings, or for work potentially effecting other facilities and existing installations, where special precautions must be taken during construction.
 - 4. Submit for review layout and design of proposed access shafts and shafts for permanent installations in accordance with Section 02400 - Tunnel Shafts.
 - 5. Ground water control system per requirements in this Section and in accordance with Section 01578 - Control of Ground Water and Surface Water, as required by construction method.
 - 6. All structural designs, including primary liner and other engineered items, must be signed and sealed by qualified Professional Engineer Registered in the State of Texas unless otherwise specified.
- C. Quality Control Methods: At least 30 days prior to start of tunneling, submit description of quality control methods proposed for use in this operation to Engineer. Include in submittal:
- 1. Supervision: Supervisory control to ensure that work is performed in accordance with Drawings and Specifications and Contractor's work plan and construction drawings.

2. Line and Grade: Procedures for surveying, controlling and checking line and grade, including field forms for establishing and checking line, and grade.
 3. Tunneling Observation and Monitoring: Procedures for preparing and submitting daily logs of tunneling operations, including field forms, to meet requirement of Paragraphs 3.06, Tunneling Data and Paragraph 3.07, Control of Tunnel Line and Grade.
 4. Monitoring Instrumentation: Conform to requirements of Paragraph 3.09A, Monitoring Instrumentation.
 - a. Name of instrument installation subcontractors.
 - b. Layout of instrumentation points.
 - c. Procedures, forms and schedules for periodic submittals of readings.
 5. Settlement Survey Plan, to meet requirements of Paragraph 3.09C, Settlement Surveying. This plan may be submitted as part of Instrumentation Monitoring Plan.
 6. Building Condition/Assessment Plans: Conform to requirements of Paragraph 3.09B, Buildings and Structures Assessment.
- D. Geotechnical and Environmental Investigation: Include results of geotechnical and environmental investigations performed by Contractor as relevant to tunneling in Tunneling Work Plan.

1.06 DESIGN CRITERIA

- A. Design primary liner for appropriate loading conditions, including but not limited to: overburden and lateral earth pressures, handling and installation stresses, loads imposed by tunnel shield or tunnel boring machine thrust jacks, subsurface soil and water loads, grouting, and all other conditions of service. Design primary liner to carry thrust of jacking or other construction forces or loads anticipated.
- B. Use Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for culverts for criteria at railroad crossings. Account for additive loadings for multiple tracks in design. Provide liner type for railroad crossings as specified or as otherwise required by railroad authority. Acceptable monitoring devices, such as closed circuit television, which permit continuous monitoring of conditions at face by qualified observers, from outside tunnel, may be used.
- C. Use HS-20 vehicle loading distributions for truck loading criteria in accordance with AASHTO.
- D. Compatibility of Methods:

1. Use compatible methods of excavation, liner, and ground stabilization and ground water control.
2. Design primary lining, when used to provide thrust for propulsion of shield, to withstand this thrust without damage or distortion. Configure propulsion jacks on shield so that thrust is uniformly distributed and will not damage or distort primary liner.
3. Use compatible tunneling method with possible restrictions on work, such as influence on existing installations or potential ground water contamination.

1.07 JOB CONDITIONS

A. Safety Requirements:

1. Perform work in manner to maximize safety and avoid exposure of men and equipment to hazardous and potentially hazardous conditions, in accordance with applicable safety standards and Contractor's safety procedures.
2. Whenever there is emergency or stoppage of work which is likely to endanger tunnel excavation or adjacent structures, operate full work force for 24 hours day, including weekends and holidays, without intermission until potentially hazardous conditions no longer exist or jeopardize stability and safety of work or existing installations.
3. Perform tunnel construction in manner that minimizes movement of ground in front and surrounding tunnel. Prevent significant subsidence of surface and protect structures and utilities above, and in vicinity of, tunnel from damage.
4. Support ground continuously in manner to prevent loss of ground and keep perimeters and faces of tunnel and bottoms of shafts stable. Use filter-fabric and other means as necessary behind primary liner to prevent soil migration into tunnel.

B. Surveillance of Headings: When Contractor is not able to close face of machine because of maintenance requirements, maintain qualified personnel on duty to observe conditions that might threaten stability of heading whenever tunnel excavation is suspended or shut down. Equip personnel with approved contingency plan to take appropriate action to prevent or limit damage should conditions which threaten stability of heading occur.

C. Air Quality:

1. Conduct tunneling operations by methods and with equipment which will positively control dust, fumes, vapors, gases or other atmospheric impurities in accordance with OSHA, Federal, State and Local requirements.

2. Provide approved mining instrumentation for testing quality of tunnel atmosphere and obtain samples, under working conditions, at prescribed intervals in accordance with above referenced requirements.
- D. Ground Conditions: Perform sufficient geotechnical exploration advance of construction to define necessary parameters for design of primary tunnel liner, planning and designing ground water control system, and for selection of tunneling method and equipment to successfully complete each tunnel reach. Present results of Contractor's geotechnical investigations in Tunnel Work Plans.

PART 2 P R O D U C T S

2.01 GENERAL

- A. Use of various construction methods for tunnel excavation and ground support, such as by tunnel boring machine (TBM), hand tunneling or shield will be allowed, provided it can be demonstrated to Engineer proposed method will complete Project in accordance with Specifications, this Section, applicable safety codes, and Project schedules.
 1. Contractor's Engineer responsible for design of primary tunnel liner system.
 2. Contractor responsible for final constructed product, materials and tools used, and for furnishing labor and qualified superintendents necessary for selected method of construction.
 3. Demonstrate that chosen method will prevent flow of water or soil into tunnel and provide stability of face under anticipated conditions.
- B. For round tunnel liner or casing, use size so minimum clearance between bottom of carrier pipe and inside of liner is minimum 4 inches, and minimum clearance between top of pipe and inside of liner or casing is in accordance with following:

<u>Carrier Pipe Net I.D.</u>	<u>Minimum Clearance to Top</u>
$\geq 48"$	9"
42"	7"
36"	5"
$\leq 30"$	3"

This clearance also applies to distance between carrier pipe and electrical conducting pipe support system. For box tunnel, provide minimum clearances shown on Drawings.

- C. Furnish TBM or shield with excavation equipment, spoil disposal systems, muck trains, hoist, grouting, signal systems, ventilation, safety equipment, and survey

controls necessary to excavate and advance tunnel and construct primary tunnel liner by selected method.

2.02 LINER AND SUPPORTS

- A. The primary tunnel liner may consist of steel ribs and lagging, steel liner plates, precast concrete segments, steel casing pipe, or combinations of these. Lagging may be timber or steel. Use box tunnels with timber supports or steel sets with timber lagging at locations shown on drawings. Utilize additional support elements including shotcrete, steel sets, breasting, spilling, forepoling, crown bars, soil anchors, or fabrics, as required to provide safe, stable excavation.
- B. Use only steel liner plates, steel casing or steel lagging with steel ring beams as primary liner for tunneling under Texas Department of Transportation rights-of-way. Use only steel casing as primary liner for tunneling under railroad rights-of-way.
- C. Use steel casing as primary liner for tunneling in fault zone crossings.

2.03 MATERIALS

- A. Where use of following materials is required, conform to requirements of following minimum standards:

<u>Material</u>	<u>Reference Standards</u>
Cement	ASTM C150
Structural Concrete	See Section 03310
Reinforcing Steel Wire	ASTM A82 or A496
Reinforcing Steel Wire Fabric	ASTM A185 or A497
Reinforcing Steel Bars	ASTM A615, Grade 60
Sand and Aggregate	ASTM C33
Structural Steel	ASTM A36
Steel Piles, Sheets	ASTM A328
Rings and Ribs	ASTM A36
Steel Plates	ASTM A36 and A283
Lumber and Timber	Hardwood, sound or better, as defined by Commercial Standard C560
Steel Casing Pipe	AWWA C200

2.04 STEEL LINER PLATES

- A. Except as otherwise specified, furnish materials according to applicable requirements of AREMA Manual for Railway Engineering.
- B. Bolts and nuts: Conform to ASTM A307, Grade A. Use bolts no less than 1/2 inch in diameter for plate gauge 7 or thinner and no less than 5/8 inch in diameter for greater plate thicknesses.

- C. Punch plates for bolting on both longitudinal and circumferential seams and fabricate to permit complete erection from inside tunnel. Use plates of uniform fabrication and use interchangeable plates for those intended for one size tunnel.
- D. Use new material for construction of liner plates. Engineer, at his option, may allow used plates provided that thickness of used plates after removal of rust is, at minimum, equal to thickness of new plates suitable for this Project; shape and dimensions meet acceptance tolerance for new plates; and used plates are free from other defects.
- E. Provide steel liner plates manufactured by Contech Construction Products (2-flange), Commercial Pantex Sika, Inc. (4-flange), or approved equal, and certified by manufacturer of compliance with specifications. Provide tensile strength, yield strength and minimum elongation of liner plates. Also, provide design calculations for either 2-or 4-flange liner plates, as appropriate for Contractor's method of construction. Steel liner plate designs shall meet following minimum factors of safety:

Seam Strength	= 3
Buckling	= 2
Maximum Deflection	= 2 Percent (of normal tunnel diameter)

- F. Maintain minimum thickness of metal for these steel plates as shown on drawings, allowing for standard mill tolerances.
- G. Equip steel liner plates with approximately 2-inch-diameter grout holes furnished with plugs. Locate holes near plate centers, such that when plates are installed there will be one line of holes along crown and along each side of tunnel, not more than 18 inches above invert. Locate holes in each line at no more than every other plate and stagger.
- H. Protective coating not required for steel liner plates, unless otherwise specified or shown on Drawings.
- I. Install gaskets between liner plates when required to control seepage, or as specified or shown in Drawings.
- J. Steel ribs used with liner plates: Conform to requirements of Paragraph 2.05, Steel Beams and Lagging.

2.05 STEEL CASING PIPE

- A. Casing pipe: Provide new uncoated welded steel pipe, manufactured in accordance with AWWA C200.
- B. Design stress in pipe wall shall be 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.
- C. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.

- D. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.
- E. Minimum thickness of steel casing shall be as shown on drawing.
- F. Casing pipe design shall also include stresses due to jacking forces when pipe is to be installed by jacking method.
- G. Equip casing pipe with approximately 2-inch diameter grout holes furnished with plugs. Place holes in pattern so that each succeeding hole from top dead center is 60 degrees right, then 60 degrees left, then top dead center. Locate holes in each line no more than 4 feet apart.
- H. Casing pipe used in fault zones conform to welding and weld testing requirements specified in Section 02502 - Steel Pipe and Fittings.
- I. Casing pipe used in fault zones must be plugged at each end with clay bricks around O.D. of pipe minimum of one foot thickness measured into casing to prevent infiltration of soil into annular space.

2.06 STEEL BEAMS AND LAGGING

- A. Steel ribs and auxiliary structural members shall be free of defects which may impair or reduce structural integrity. Ribs shall be accurately curved to proper radius of tunnel section (or shaft section) for round tunnel liners. Rib segments shall fit closely for bolted connections at segmental and transverse joints. Provide steel appurtenances required for installation of ribs such as tie rod, bolts, splice plates, dutchmen and drift pins, with ribs.

- B. Minimum factors of safety:

$$\begin{aligned}\text{Buckling} &= 2 \\ \text{Stiffness} &= 3\end{aligned}$$

2.07 FILTER FABRIC

- A. See Section 02621 - Geotextile for requirements of material and minimum installation requirements. Install fabric, and backer rods, as required to prevent loss of fine-soil sediments into tunnel.

2.08 TIMBER

- A. Use new timber for primary liner ground support without defects, of true dimensions and of quality grade and wood type defined by Contractor's Engineer.
- B. Maximum length: 4 feet.

2.09 PRECAST REINFORCED CONCRETE BOX SEWERS

- A. See Section 02612 - Precast Reinforced Concrete Box Sewers for requirements of material and minimum installation requirements.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contractor shall be responsible for his means and methods of tunneling construction and shall ensure safety of work, Contractor's employees, public, and adjacent property, whether public or private.
- B. Execute work of excavating, lining, grouting, and construction of tunnel so that ground settlement or loss will be minimized. Completed primary tunnel lining shall have full bearing against earth with no voids or pockets left in work. Fill peripheral space between support elements and excavated surface no less frequently than after each shore or close by expanding support elements against ground as shield advances.
- C. Maintain clean working conditions inside tunnel and remove muck, debris, material spills, unusable supports, and other material not required for tunneling.
- D. Be aware that various existing soil borings, piezometers, or instrument wells may coincide with proposed tunnel alignment. These may or may not have been backfilled with grout and therefore caution should be used in tunneling through these existing borings. Take mitigating measures to counter effect these boreholes, piezometers, or instrument wells may have on tunneling operations.
- E. Perform tunneling under railroad embankments, highways, or streets to prevent interference with operation of railroad, highways, or streets.
- F. Do not perform any surface activities or disruptions within limits of tunnel area unless otherwise approved by Engineer.

3.02 GROUND WATER CONTROL AND GROUND STABILIZATION

- A. Provide necessary ground water control measures to perform work and to provide safe working conditions. Prevent excessive inflow of water into excavation during construction of tunnel and installation of carrier pipe and grouting of annular space. Ground water control method shall provide means to prevent piping of fines into shafts or tunnel and other adverse effects due to ground water inflow. Additional requirements are included in Section 01578 - Control of Ground Water and Surface Water. Other methods of construction, including tunnel work under compressed air, may be considered when Contractor is able to demonstrate that it will prevent flow of materials or water into tunnel excavation and allows construction of work to meet requirements of drawings and specifications. Additional requirements are included in Section 01578 - Control of Ground Water and Surface Water.

- B. Anticipate that portions of tunnel excavation may be below ground water table and in cohesionless soils, even when not indicated on soil borings, and in conditions which may require ground water control system for tunneling operations. Install filter fabrics, backer-rods and other means as necessary to prevent piping of fines into tunnel. Remove water that may be encountered during course of work by pumping, well pointing, deep well pumping, or other means as necessary to achieve stable conditions and applied in manner as described in Section 01578 - Control of Ground Water and Surface Water. Standing water not permitted at face, in tunnel or shafts.
- C. The ground water control method used shall not cause damage to adjacent structures or property due to lowering of water table and subsequent ground settlement.
- D. If Contractor chooses pumping installations to control ground water level or installs pervious liner through water bearing layers, install and maintain instrumentation system to monitor water level and to detect movement in adjacent structures and property. Monitor water level by recording initial water level before dewatering is started and thereafter on weekly basis. Remove water monthly from piezometers to demonstrate that they are operable. Submit weekly reports of water levels to Engineer. Provide access to piezometers for Engineer to perform independent measurements.
- E. Maintain dewatering system for tunnels in continuous operation until minimum of 48 hours after carrier pipe has been installed and annular space is fully grouted, or until watertight liner designed for hydrostatic pressures is installed.
- F. If eductors, well points or deep wells are used, space them adequately to provide necessary dewatering. Use sand packing, and other means to prevent pumping of fine sands or silts from subsurface and to minimize ground subsidence. Check continuously to ensure that subsurface soil is not being removed by ground water control operation or subsurface drainage into shafts or through pervious liner. Before operations begin, maintain availability of pumping equipment and other machinery on site to assure that operation of dewatering system can be maintained.
- G. When groundwater control is necessary, do not begin tunneling operations until monitoring data shows that it is safe to do so. When dewatering is sole means of ground water control, draw piezometric level down below elevation of invert of tunnel, or to lower elevation as required for excavation face and tunnel stability.

3.03 EQUIPMENT

- A. Use tunneling method, whether hand or machine, with full-face closure capabilities.
- B. Diesel, electrical, hydraulic, or air-powered equipment will be acceptable, subject to applicable Federal and State regulations. Diesel engines equipped with scrubbers are acceptable only when tunneling in free air with adequate ventilation. Provide compressed air and electricity for Contractor's operations from source outside tunnel.

- C. Tunnel Boring Machine: When tunnel boring machine is used, employ equipment that will be capable of handling various anticipated ground conditions. In addition, TBM shall:
1. Be capable of minimizing loss of ground ahead of and around machine and providing satisfactory support of excavated face. Use TBM with, when necessary for ground control, earth-pressure balance or slurry-shield capabilities.
 2. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over-excavation or voids. TBM shield shall be continuous around its full perimeter; open-bottom shield is not acceptable.
 3. Have tail section long enough to enable setting of initial supports within machine, while still providing at least 12-inches of overlap beyond last installed support elements when thrusting jacks are extended to fullest extent possible.
 4. Have propulsion jacks capable of moving machine in forward direction while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel supports. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.
 5. Incorporate seal in TBM tail shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.
 6. Have motors and operating controls protected against water inflow.
 7. Provide bi-directional drive on cutter head wheel, or fins or grippers to control roll due to rotation.
 8. Provide means for maintaining tunnel face under wet and adverse soil conditions. Use closure doors on cutter wheel or other means, such as earth-pressure balance or slurry shield, acceptable to Engineer.
- D. Tunnel Shield: tunnel shield is used (with or without attached mechanized excavating equipment), employ shield be capable of handling various anticipated ground conditions. In addition, shield shall:
1. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over excavation or voids. Appropriately sized overcutting bead or taper along length of shield may be provided to facilitate steering. Shield shall be continuous around its full perimeter; open bottom shield is not acceptable. Although it is recognized that capability to over excavate beyond perimeter of shield may be necessary under certain conditions, make provisions to prevent accidental over excavation.

2. Have hood, poling or breasting plates, shelves and breast jacks, breast tables, and combinations of these and other bracing as necessary to fully support face of tunnel excavation without loss of ground.
 3. Have tail section long enough to enable setting of initial supports within shield while still providing at least 12-inches of overlap beyond last-installed support elements when shield has been pushed forward to fullest extent possible.
 4. Have propulsion system for moving shield in forward direction, while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel support. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.
 5. Have motors and operating controls protected against water inflow.
 6. Incorporate seal in tail of shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.
- E. Air Quality: Provide equipment to adequately ventilate entire tunnel operation during construction.
1. Provide portable testing equipment for carbon monoxide gas, hydrogen sulfide gas, oxygen deficiency, and explosive gases. Monitoring for other constituents may be required while tunneling in potentially contaminated areas as defined in Contractor's safety plan.
 2. Provide audible automatic gas alarm on TBM to detect explosive gases. Locate alarm near tunnel face.
 3. Equip motors and controls with automatic shutoff methane monitoring system.
- F. Lighting: Provide adequate lighting with lights at 50 feet, maximum spacing in tunnel. Fixtures shall be in watertight enclosures with suitable guards. Provide separate circuits for lighting and for electrical equipment.
- G. Electrical: Equip electrical systems utilized on TBM with appropriate ground fault system. Electrical systems are to be insulated, not permitting bare-wire exposures.
- H. Access: Provide safe access through tunnel to TBM.
1. Provide walkway in tunnels greater than 10 feet in diameter which is separate from tracks used by spoil removal equipment.
 2. Equip locomotives or cars used for transport of personnel with necessary safety devices.

- I. Necessary equipment for tunnel excavation includes telephones, signal systems, fire extinguishers, safety equipment, and other equipment required by Contractor's method of construction, Tunnel Work Plan and safety plan. Maintain equipment in good repair, and readily available at place of work.

3.04 SHAFTS

- A. Construction of Shafts: Conform work for all shafts, with or without permanent structures in them, to requirements of Section 02400 - Tunnel Shafts. Select shaft locations in agreement with planned method of tunneling. Appropriately size shafts.

3.05 TUNNEL EXCAVATION AND PRIMARY LINER INSTALLATION

A. Tunnel Excavation:

1. Conduct tunneling operations in accordance with applicable safety rules and regulations, and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.
2. Limit tunnel excavation to within easements and rights-of-way indicated on Drawings, and to lines and grades designated on Drawings. Perform excavation of sufficient size to allow installation of water line to lines and grades indicated on Drawings.
3. Locate equipment powered by combustible fuels at suitable distances from shafts to prevent possibility of explosion and fire in shafts or tunnel.
4. During open-face excavation:
 - a. Excavate face commencing at crown and proceed down to invert. Excavate both sides of heading simultaneously. Keep hood buried in soil ahead where soils include sands and silts.
 - b. Keep face breasted or otherwise supported; employ other means as necessary to maintain face stability and prevent falls, excessive ravelling, or erosion. Maintain standby face supports for immediate use when needed.
 - c. During shut-down periods, support face of excavation by positive means; do not rely solely on hydraulic pressure for support. When face is untouched for more than 24 hours, and when required by Engineer, fully breast face and shove shield tight against it.
5. During closed-face excavation:
 - a. Carefully control and monitor volume of spoil removed. For earth-pressure balance TBM, balance spoil removed with advance rate and excavation rate.

- b. When cutting face is withdrawn, keep excavated face stabilized as required.
 6. Advancing Shield: During forward movement of shield, provide sufficient support at excavation face to prevent movement of materials except materials as are physically displaced by elements of shield itself.
- B. Size of Tunnel: Determine adequate tunnel size and section to match construction methods described in work plan. Construct tunnels of sufficient size to permit efficient excavation operations, to provide sufficient working space for placing primary tunnel liner, and to allow for installation of water line. Dimensions shown on Drawings represent minimum dimensions acceptable to Engineer and do not necessarily represent size or section suitable for construction methods or operational procedures as may be proposed or conducted by Contractor.
- C. Primary Liner:
 1. Provide primary liner for tunnel which is capable of supporting ground, and hydrostatic forces until permanent water pipe has been installed and grouted in place, and to resist construction loads.
 2. Use methods that ensure full bearing of soil against primary liner without significant settlement or movement of surrounding soil. To fill void behind primary liner, either expandable liner (e.g., ring beams and timber lagging) or non-expandable liner (e.g., bolted steel liner plates) may be used provided grout is placed behind non-expandable liner. Where ground is excavated to true shape box tunnel may be un-grouted at contractor's discretion. Grout excavation not to true shape as result of over excavation or loss of ground.
 3. The primary liner's seepage inflow for each 100-foot length of tunnel shall not exceed 3 gallons per minute, including inflow through face or shield. Localized inflow shall not exceed 0.5 gallons per minute. Provide drainage facilities to remove inflow of water from tunnels and shafts. Provide means to prevent inflow of soil fines associated with water inflow by use of filter fabrics or other approved methods.
 4. Expandable liner shall be continuous and shall be expanded to limits of excavation promptly after it is out of shield.
 5. During excavation of tunnel, advance TBM or shield only far enough to permit construction of one primary liner ring beam set, or rings of bolted steel liner plates that can be assembled entirely within tail shield of TBM.
 6. Install filter fabric around exterior of primary liner when using non-watertight liner and when tunneling through sandy or silty ground conditions. Install backer rods at ribs as required to control migration of fines. Close windows in lagging.

7. Provide hog rods, struts or similar members when required to maintain primary liner shape. After grouting liner, deflection shall be no more than 3 percent as measured by difference between maximum and minimum measured diameter divided by average diameter.

D. Hand Jacking of Casing:

1. Provide heavy-duty jacks of capacity suitable for forcing casing pipe through ground. Construct operating jacks so that even pressure is applied to all jacks used. Provide suitable jacking head, (timber, etc.), and suitable bracing between jacks and jacking head. Provide suitable jacking frame and/or back stop. Set casing pipe to be jacked on guides, (timber, etc.), properly braced together, to support section of pipe and direct it to proper line and grade. Place whole jacking assembly so as to line up with direction and grade of casing pipe.
2. Excavate ground material just ahead of casing pipe by use of air-powered tools, excavating machine or other acceptable means, and remove through casing pipe. Then force casing pipe through ground with jacks, into space thus provided. Dispose excavated material as specified.
3. Trim excavation in manner so that at least one third of circumference of excavation conforms to contour and grade of casing pipe. Provide clearance of not more than 2 inches for upper half of casing pipe with clearance tapering off to zero at point where excavation conforms to contour of casing pipe. Cutting edge of steel plate installed around head end of casing pipe extending short distance beyond end of casing pipe with inside angles or lugs to keep cutting edge from slipping back onto casing pipe may be used.
4. In addition to requirements set for in this specification:
 - a. Excavate face commencing at crown and proceed down to invert. Excavate heading so that both sides of heading are excavated simultaneously.
 - b. At all times maintain standby face supports to allow for immediate use when needed.
 - c. At end of each shift and whenever excavation is suspended or shut down, install breast boards, or other approved methods, across full face of heading.
5. Distance that excavation extends beyond end of casing pipe shall not exceed three feet. Decrease this distance as directed by Engineer, or due to character of material being excavated.

6. The casing pipe, insofar as practical, jack from low or downstream end. Lateral or vertical variation in final position of casing pipe from line and grade as established by Engineer will be permitted only to extent of 1 inch in 10 feet, provided that variation is regular and only in one direction and that final grade of flow line is in direction indicated on plans. Remedy overcutting by pressure grouting entire length of installation. Use of grout mix immediately behind shield tail shall have efficient tail seal to prevent flow of grout into shield.
 7. Depending on character of soil encountered during jacking operation, carry on operation without interruption, insofar as practical, to prevent casing pipe from becoming firmly set in ground.
 8. Remove and replace casing pipe damaged in jacking operations by Contractor at no additional cost to Owner.
 9. Backfill pits or trenches which have been excavated to aid jacking operations as soon as casing pipe is complete in place, equipment and appurtenances have been removed and structure, which is to be built in excavated zone, is in place. In no case shall shafts remain open without appropriate safety barricades, concrete traffic barriers (CTB's), railing or plates.
 10. When jacking casing pipe, water jetting of casing pipe bedding or backfill is not allowed. In unconsolidated soil formations, use gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade fully hydrated bentonite to seal voids outside walls and furnish lubrication for installation of casing pipe.
- E. Grouting:
1. Furnish and operate suitable equipment for grouting operations to effectively and completely fill voids outside of primary tunnel liner as quickly as possible.
 2. Additional requirements pertaining to grout mix design and tunnel grouting are provided in Section 02431 - Tunnel Grout.
 3. Provide in Tunneling Work Plan description of primary liner grouting operations, including:
 - a. Arrangement of grouting equipment including mixer, pumps, piping and hoses, valves, pressure gauges and injection fixtures.
 - b. Location, spacing and size of grout ports and vents.
 - c. Grouting sequence for initial backfill of voids between liner and ground, and for second stage back grouting.
 - d. Grout injection pressures and estimated volumes.

- e. Procedure to check for remaining voids.
 - f. Sampling procedures and locations for quality control testing.
 - g. Grout production and quality shall be in accordance with Contractor's mix design and grout production plan as required by Section 02431 - Tunnel Grout.
- 4. Use care in grouting operations to prevent damage to adjacent utilities or other properties. Ensure that pressure used in grouting is not great enough to distort or imperil work.
 - 5. Fill voids behind non-expandable primary liner with sand-cement grout promptly after liner is out of shield. Grout pressure shall not exceed value that may cause damage or distortion to installed liner plate rings. Grout from bottom up and plug each grout hole promptly after grout has been placed. Provide seals on tail of TBM which will prevent grout from moving into shield.
 - 6. Place grout behind tunnel liner at end of each day or at every 5 feet of tunnel installed, whichever is less, unless in opinion of Engineer, ground conditions are such as to require each ring to be grouted immediately after erection. Upon completion of each grouting operation, sound primary liner and immediately correct voids discovered by necessary means as approved by Engineer. After all voids are successfully filled, grout holes will be packed, when necessary, with dry mortar mix and threaded taps securely placed in holes.
 - 7. Place Grout behind tunnel liner at end of each day or at every 5 feet of tunnel installed, whichever is less, unless in opinion of Engineer, ground conditions are such as to require each ring to be grouted immediately after erection. Upon completion of each grouting operation, sound primary liner and immediately correct voids discovered by necessary means as approved by Engineer. After all voids are successfully filled, grout holes will be packed, when necessary, with dry mortar mix and threaded taps securely placed in holes.
 - 8. Perform quality control sampling and testing of grout.
 - a. Grout production shall be in accordance with Section 02431 - Tunnel Grout.
 - b. Measure density of grout throughout placement procedure as directed by Engineer. Measure grout density at discharge point and discharge grout until density is within 0.3 pounds per gallon of input density.
 - c. Take samples of well-mixed grout for 28-day compressive strength tests at beginning, middle and end of each grouting operation.

3.06 TUNNELING DATA

- A. Submit shift logs of construction events and observations within 24 hours of operation on at least following:
 - 1. Location of face by station and progress of tunnel drive during shift.
 - 2. Observation of lost ground and other signs of ground movement.
 - 3. Location and elevation of significant soil strata boundaries and brief soil descriptions.
 - 4. Ground water control operations, piezometric levels, ground water inflow location and rates.
 - 5. Completed field forms for establishing and checking line and grade and achieved tolerance relative to design alignment.
 - 6. Operation shut-down periods or other interruptions in work, and reason.
 - 7. Any unusual condition or event.
- B. Clearly mark primary liner every 20 feet along tunnel with distance in feet from centerline of preceding shaft.

3.07 CONTROL OF TUNNEL LINE AND GRADE

- A. Construction Control:
 - 1. Check established baseline and benchmarks indicated on Drawings at beginning of work and report errors or discrepancies to Engineer.
 - 2. Use baseline and benchmarks established by Engineer to furnish and maintain reference lines and grades for construction. Use these lines and grades to establish location of tunnel, water line, and structures.
 - 3. Establish and be fully responsible for accuracy of controls for construction of Project, including access shaft locations, structures, tunnel line, and grade. Utilize laser to insure line and grade are maintained during tunneling process.
 - 4. Establish control points sufficiently removed from tunnel operation not to be affected by potential ground movement.
 - 5. Maintain daily surveying records of alignment and grade and submit three copies of records to Engineer by end of day after work performed. Locate points at top, bottom and each side of springline.

6. Check tunnel survey control against aboveground undisturbed reference at least once each week and once for each 250 feet of tunnel constructed, or more often as needed or directed by Engineer.
- B. Earth Movement:
1. Take precautions to avoid damage or settlement to buildings, structures, roads, and utilities to work in proximity of tunnel. Minimum precautions to include use of construction methods and equipment to minimize loss of earth at tunnel face and settlement of soil around primary tunnel liner.
 2. Refer to Paragraph 3.09, Monitoring for detecting earth movement.
 3. In event movement of ground is detected, Engineer may order work stopped and secured. Before proceeding, correct problems causing or resulting from movement.
 4. Be aware that when settlement of ground surface should occur during construction of tunnel which will affect accuracy of temporary benchmarks established by Engineer, detect and report movement. Advise Engineer of settlement affecting permanent monumentation benchmarks. Upon completion, submit field books pertaining to monitoring of permanent monumentation benchmarks to Engineer.
 5. TxDOT does not allow any settlement of pavements in its Right of Way. Pressure grouting from the surface may be utilized to raise settled pavement with TxDOT approval at no separate pay. Refer to Pressure Injected Epoxy on the following pre-approved procedure from TxDOT:
 - a. <http://onlinemanuals.txdot.gov/txdotmanuals/crm/crm.pdf>
 - b. Other means approved by TxDOT and at no separate pay may be utilized to repair impacted pavement.
- C. Tunnel Line and Grade:
1. Survey crown, invert, and springline on each side of primary liner at 50-foot intervals, or minimum of once per shift, or more frequently when line and grade tolerances have been exceeded, to ensure alignment is within tolerances specified. Conduct survey immediately behind tunnel excavation to allow immediate correction of misalignment.
 2. When excavation is off line and grade, make corrections to plan line and grade at rate of 3 inches per 100 feet.
 3. Control excavation of tunnel and construction of primary liner to allow construction of carrier pipe within 6 inches on line and 4 inches on grade and to maintain circular shape of tunnel.

4. Alignment adjustments between primary tunnel liner and water main shall not encroach on minimum required clearance of 4 inches defined in Section 02517 - Water Line in Tunnels.
5. If unable to maintain specified tolerances, bear full responsibility and expense of correction (redesign, easement acquisition, etc.) when these tolerances are exceeded and redesign of structures is required, obtain services of qualified Professional Engineer registered in the State of Texas for redesign. Submit plans showing changes to Engineer for review.
6. Backfill (grout) and reconstruct tunnel built outside tolerance or which is outside Authority's right-of-way to be within tolerance when so directed by Engineer.

3.08 TUNNEL CONNECTIONS, TERMINATIONS, AND TEMPORARY BULKHEADS

- A. Connect new tunnels to existing structures by removing existing bulkheads, when necessary, and sealing junction as shown on Drawings.
- B. Seal terminations of tunnels, which are not connected to permanent structures, by temporary bulkhead.
- C. Design temporary bulkheads where and when required and obtain Engineer's acceptance of design prior to constructing it. Provide bulkheads capable of resisting lateral earth and hydrostatic pressures, waterproof, and capable of being removed without damaging water line or plastic liner.

3.09 MONITORING

- A. Monitoring Instrumentation: This specification establishes minimum instrumentation requirements for tunneling. Additional instrumentation requirements for critical areas may be specified elsewhere in Specifications, in the Geotechnical Reports, and/or on Drawings. Contractor may install more extensive system at Contractor's sole expense. Instrumentation specified shall be accessible at all times to Engineer and Permitting Authorities at tunnel locations subject to Permitting Authorities' jurisdiction (e.g. TxDOT and County locations).
 1. Submit for review, prior to construction, Monitoring Plan including instrument installation design, instrumentation points, location and layout, manufacturer's catalog literature, installation report formats.
 2. Install and maintain system of instrumentation to monitor tunneling operation and to detect movement in soil and adjacent structures. Instruments shall consist of no less than sufficient number of inclinometers and crack monitors at bridge and adjacent structures and sufficient piezometers. Use monuments sufficiently removed from construction to avoid errors in readings due to ground settlement.

3. Installation of instrumentation shall not preclude Engineer, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for independent installations.
 4. Install soil instruments such as piezometers, inclinometers, extensometers, and crack monitors by qualified subcontractor specializing in geotechnical work.
 5. Install extensometers to depth of 5 feet above crown of water line tunnel as shown on Drawings to measure vertical movements in soils during and subsequent to tunneling. Extensometer consists typically of three-prong anchor, 1/4-inch standard stainless steel inner pipe, and 1-inch standard Schedule 80 PVC outer pipe. Pipes are assembled in sections and fastened together with standard couplings to required anchor depths. Locate top of extensometer within flush-mounted hand-hole cover capable of withstanding HS-20 truck loading. Geotechnical instrumentation installation subcontractor shall provide procedures for installation of extensometers as part of Monitoring Plan.
- B. Building and Structures Assessment: Submit for review prior to construction, Building and Structures Assessment Plan. Provide preconstruction and post-construction assessment reports for buildings and structures located within distance equal to depth of tunnel but at least 50 feet in plan from proposed tunnel centerline and shafts. Include photographs or video of existing damage to structures in vicinity of water line alignment in assessment reports.
- C. Settlement Surveying: This specification establishes minimum settlement survey requirements for structures and ground surface monitoring points.
1. Submit settlement surveying and monitoring plan for review prior to construction. Plan shall identify location of settlement monitoring points, reference benchmarks, survey schedules and procedures and reporting formats.
 2. Locate survey points on all structures within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline.
 3. Record horizontal coordinates and elevations (with accuracy of 0.01 feet) for each survey point location. Reference survey points so that they may be accurately re-established when lost or destroyed.
 4. Unless otherwise specified, prior to start of tunneling excavation, establish ground surface elevation monitoring points on cross sections over the tunnel limits. Cross section monitoring points shall be established on the tunnel center line and at 10 foot intervals extending 50 feet on either side of center line. Cross sections shall be spaced at 20-foot intervals or at least three locations per tunnel drive, whichever results in the shorter interval between cross sections. Record ground surface elevations at monitoring points prior to start of

tunneling excavation to establish baseline condition. When tunneling excavation begins, and for the duration of the excavation, record elevations of monitoring points starting at the beginning of the excavation to 100 feet ahead of TBM. Continue monitoring along cross sections for a minimum of 8 weeks after the TBM has passed the cross section location, or until the TBM is 100 feet beyond the cross section location, whichever results in the longer period. In the event of movement in ground surface elevation is detected, the monitoring period shall be according to the above requirements and shall continue for a minimum of two weeks past the last measurement showing movement has ceased, unless otherwise directed by Engineer.

5. In addition to the requirements of Paragraph 3.09.C.4, locate survey points at crossings under installations as follows:
 - a. Roads: Road Centerline and each shoulder of the road over the centerline of the tunnel
 - b. Utilities and Pipelines: Directly above and 10 feet before and after intersection.
 6. For shaft settlement see Section 02400 - Tunnel Shafts.
 7. Measure excavated volume and compare to calculated volume of the tunnel. When excavated volume exceeds calculated volume, report to Engineer and Permitting Authorities at tunnel locations subject to Permitting Authorities' jurisdiction (e.g. TxDOT, and County).
- D. Measure and maintain records of deformation of primary liner.
- E. Reading Schedule and Reporting: Submit readings from various instruments and survey points weekly to Engineer and Permitting Authorities at tunnel locations subject to Permitting Authorities' jurisdiction (e.g, TxDOT and County locations). Take daily Readings as required by Engineer and when construction is approaching or near critical structures (structures, pipelines, etc., partially or entirely located within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline). Take initial readings of surface points before excavation or construction is started.

Immediately report to Engineer and Permitting Authorities at tunnel locations subject to Permitting Authorities' jurisdiction (e.g. TxDOT and County locations) movement, cracking, or settlement which is detected and take immediate remedial action. Contractor shall be fully responsible for damage to adjacent structures.

At end of construction after water line is installed- and dewatering is discontinued, or after other specific monitoring period indicated in Specification 0111O has passed, make final survey of control points established for instrumentation and observation. Submit final readings to Engineer and Permitting Authorities at tunnel locations subject to Permitting Authorities' jurisdiction (e.g. TxDOT and County locations).

Make visual inspection of structures adjacent to water line and report to Engineer and Permitting Authorities at tunnel locations subject to Permitting Authorities jurisdiction (e.g. TxDOT and County locations) condition of structures, damage incurred during construction, and corrective action taken.

3.10 DISPOSAL OF EXCESS MATERIAL

- A. Remove spoil from job site and dispose in accordance with Section 01504 - Temporary Facilities and Controls.

END OF SECTION

Section 02441

MICROTUNNELING AND PIPE-JACKED TUNNELS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Tunnel construction of sewers by one-pass methods with or without man entry. Construction methods involve jacking pipe following hand-shield excavation or tunnel boring machine (TBM) or micro-tunnel boring machine (MTBM), with pipe serving as both tunnel liner during construction and sewer pipe after completion of construction.
- B. Select fiberglass reinforced pipe (FRP), vitrified clay pipe (VCP), reinforced concrete pipe (RCP) for storm or sanitary sewers and reinforced concrete box (RCB) for storm sewers. Use plastic-lined RCP for sanitary sewers. Unlined RCP or RCP lined with liner other than that specified in Section 02427 - Plastic Liner for Large Diameter Concrete Sewers and Structures will not be allowed for sanitary sewers.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Length of sewer installed will be measured by linear foot along center line of completed sewer from center line to center line of manholes, as designated on Drawings; and to end of stubs or termination of pipe; and to inside face of lift station and treatment plant works. Installation of sewer within limits of structure other than manholes will not be considered for measurement and payment at unit price bid.
 - 2. Payment will include and be full compensation for labor, equipment, materials, and supervision for construction of sewer and excavation, complete in place including disposal of excess materials, sheeting, shoring or bracing, dewatering, utility adjustments, connections to existing sewers, grouting when required, tests, backfilling, clean-up, and other related work necessary for construction as specified or as shown on Drawings.
 - 3. Payment for installation of sewer will be authorized by Engineer in two parts. Pay estimates for partial payments will be made as measured above according to following schedule:
 - a. 95 percent payment will be made for jacked pipe installed but not

yet grouted, in cases where grouting is specified.

- b. 100 percent payment will be authorized on linear foot basis for amount of jacked sewer pipe installed, including grouting when specified.

- 4. Monitoring will be paid for at lump sum price for installations, observations, and reporting.

- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.
- B. American Association of State Highway and Transportation Officials (AASHTO).
- C. Occupational Safety and Health Administration (OSHA).
- D. National Electrical Code - (NFPA 70).

1.4 DEFINITIONS

- A. Jacked Pipe: Method for installing sewer pipe that serves as initial construction lining and tunnel support, installed for stability and safety during construction, and as sewer pipe. Pipe is shoved forward, or jacked, as tunnel is advanced.
- B. Microtunneling: Method of installing pipe by jacking pipe behind microtunnel boring machine which is connected to and shoved forward by pipe being installed, generally precluding man entry.
- C. Tunnel Boring Machine (TBM): Mechanized excavating equipment that is steerable, guided and articulated, connected to and shoved forward by pipe being installed, with man entry.
- D. Microtunnel Boring Machine (MTBM): Mechanized excavating equipment that is remotely- controlled, steerable, guided and articulated, connected to and shoved forward by pipe being installed, usually precluding man entry.
- E. Tunneling Methodology: Written description, together with supporting documentation that defines plans and procedures for microtunneling or pipe jacking operations.
- F. Zone of Active Excavation: Area located within radial distance about surface

point immediately above face of excavation equal to depth to bottom of excavation.

- G. Critical Structure: Building, structure, bridge, pier, or similar construction partially or entirely located within zone of active excavation.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

- B. Following submittals are required:

1. Tunneling Methodology. Brief description of proposed tunnel methodology. Description should be sufficient to convey following:
 - a. Proposed method of tunnel construction and type of face support.
 - b. Manufacturer and type of tunneling equipment proposed; type of lighting and ventilation systems.
 - c. Number and duration of shifts planned to be worked each day.
 - d. Sequence of operations,
 - e. Locations of access shafts and work sites.
 - f. Method of spoil transportation from face, surface storage and disposal location.
 - g. Capacity of jacking equipment and type of cushioning.
 - h. Identify critical utility crossings and special precautions proposed.
2. Drawings and Calculations: Submit for record purposes, drawings and calculations for tunnel support system. Provide adequate drawings and installation details for construction. For pipe jacking and microtunneling, show pipe and pipe joint detail. Documents must be signed and sealed by Professional Engineer registered in State of Texas. Calculations shall include clear statement of criteria used for design as described in Paragraph 1.06, Design Criteria.
3. Quality Control: Submit for review brief description of quality control methods including:
 - a. Method and frequency of survey control.

- b. Example of tunnel daily log.
- 4. Geotechnical Investigation: When geotechnical investigations are conducted, submit results to Engineer for record purposes.
- 5. Monitoring Plans:
 - a. Instrumentation Monitoring Plan: Submit for review, prior to construction, monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.
 - b. Surface Settlement Monitoring Plan. Submit settlement monitoring plan for review prior to construction. Identify on plan location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.
- 6. Structures Assessment. Provide preconstruction and post construction assessment reports for critical structures, namely those located within zone of active excavation from proposed tunnel centerline. Include photographs or video of existing damage to structures in vicinity of sewer alignment in assessment reports.
- 7. Readings of all monitoring shall be submitted to Engineer.
- 8. Daily Reports: Maintain shift log as defined in Paragraph 3.04, Pipe-jacked Tunneling Data, and make available to Engineer on request.

1.6 DESIGN CRITERIA

- A. Assume responsibility for selection of appropriate pipe and pipe joints to carry thrust of any jacking forces or other construction loads in combination with overburden, earth and hydrostatic loads. Design of any pipe indicated on Drawings considers in-place loads only and does not take into account any construction loads. Criteria for longitudinal loading (jacking forces) on pipe and joints shall be determined, based on selected method of construction.
- B. Jacked pipe shall be designed to withstand thrust from MTBM, TBM or shield and pipe advance without damage or distortion. Propulsion jacks shall be configured so that thrust is uniformly distributed and will not damage or distort pipe.
- C. Take into account loads from handling and storing.

- D. Criteria to be used at railroad crossings shall be Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks.
- E. Criteria to be used for truck loading shall be HL-93 vehicle loading distributions in accordance with the AASHTO LRFD Bridge Design Specification.
- F. Provide pipes of diameter shown on Drawings. Substitution of pipe with larger diameter to suit MTBM or TBM equipment availability will only be permitted if demonstrated to satisfaction of Engineer that design flows and velocities can be achieved.

PART 2 P R O D U C T S

2.1 SEWER PIPE

- A. Assume responsibility for selecting appropriate pipes and pipe joints to safely carry loads imposed during construction, including jacking forces. Pipe joints shall be flush with outside pipe face when pipes are assembled. Pipe materials shall be selected from following:
- B. Fiberglass Reinforced pipe, joints, and fittings to be in accordance with Section 02504 - Fiberglass Reinforced Pipe.
- C. Vitrified clay pipe, joints and fittings to be in accordance with Section 02508 - Extra Strength Clay Pipe.
- D. Plastic-lined reinforced concrete pipe with joints and fittings to be in accordance with Section 02611 - Reinforced Concrete Pipe and Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures. Plastic liner is not required for storm sewers.
- E. Use pipe that is round with smooth, even outer surface, and has joints that allow for easy connections between pipes. Design pipe ends so that jacking loads are evenly distributed around entire pipe joint and such that point loads will not occur when pipe is installed. Pipe used for pipe jacking shall be capable of withstanding all forces that will be imposed by process of installation, as well as final in-place loading conditions. Protect driving ends of pipe and joints against damage.
- F. Precast Reinforced Box with joints and fittings in accordance with Section 02612- Precast Reinforced Concrete Box Sewers. Precast concrete box is not acceptable for Sanitary Sewers.

PART 3 EXECUTION

3.1 CONSTRUCTION OPERATIONS CRITERIA

- A. Use methods for microtunneling and pipe-jacked tunneling operations that will minimize ground settlement. Select method which will control flow of water and prevent loss of soil into tunnel and provide stability of face under anticipated conditions.
- B. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA standards and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.
- C. Maintain clean working conditions wherever there is man access.
- D. For tunneling under railroad embankments, highways, or streets, perform installation so as to avoid interference with operation of railroads, highways, or streets, except as approved by owner of facility.

3.2 GROUND WATER CONTROL

- A. Provide ground water control measures in conformance with Section 01578 - Control of Ground and Surface Water, when necessary to perform Work.

3.3 EQUIPMENT

- A. Full directional guidance of shield, TBM, or MTBM is prerequisite of this method of construction.
- B. Assume responsibility for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.
- C. Employ tunneling equipment that will be capable of handling various anticipated ground conditions and is capable of minimizing loss of soil ahead of and around machine and shall provide satisfactory support of excavated face.
- D. Tunnel Boring Machine (TBM). A TBM used for pipe-jacking shall conform to shape of tunnel with uniform perimeter that is free of projections that could produce over- excavation or voids. Appropriately sized overcutting bead may be provided to facilitate steering. In addition, it shall:
 - 1. Be capable of full face closure.
 - 2. Be equipped with appropriate seals to prevent loss of bentonite lubricant.

3. Be capable of correcting roll by reverse drive or fins.
 4. Be designed to handle adverse ground conditions including ground water ingress.
 5. Be equipped with visual display to show operator actual position of TBM relative to design reference.
- E. Tunnel Shield. If hand shield is used for pipe-jacked tunneling (with or without attached mechanized excavating equipment), shield must be capable of handling various anticipated ground conditions. In addition, shield shall:
1. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over-excavation or voids. Appropriately-sized overcutting bead may be provided to facilitate steering.
 2. Be designed to allow face of tunnel to be closed by use of gates or breasting boards without loss of ground.
- F. Microtunneling Equipment. In case of MTBM, use spoil transportation system which:
1. Balances soil and ground water pressures by use of slurry or earth pressure balance system; system shall be capable of adjustments required to maintain face stability for particular soil condition and shall monitor and continuously balance soil and ground water pressure to prevent loss of slurry or uncontrolled soil and ground water inflow, or, in case of slurry spoil transportation system:
 - a. Provides pressure at excavation face by use of slurry pumps, pressure control valves, and flow meter.
 - b. Includes slurry bypass unit in system to allow direction of flow to be changed and isolated, as necessary.
 - c. Includes separation process. Design it to provide adequate separation of spoil from slurry so that slurry with sediment content within limits required for successful tunneling can be returned to cutting face for reuse. Appropriately contain spoil at site prior to disposal.
 - d. Uses type of separation process suited to size of tunnel being constructed, soil type being excavated, and work space available at each work area for operating plant.

- e. Allows composition of slurry to be monitored to maintain slurry weight and viscosity limits required.
- 2. In case of cased auger earth pressure balance system, system shall be capable of adjustments required to maintain face stability for particular soil condition to be encountered. Monitor and continuously balance soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.
 - a. In cased auger spoil transportation system, manage pressure at excavation face by controlling volume of spoil removal with respect to advance rate. Monitor speed of rotation of auger flight, and addition of water.
- 3. Remote Control System. Provide MTBM which includes remote control system with following features:
 - a. Allows for operation of system without need for personnel to enter tunnel. Has display available to operator, at remote operation console, showing position of shield in relation to design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force, and cutter head torque; rate of advance and installed length.
 - b. Integrates system of excavation and removal of spoil and its simultaneous replacement by pipe. As each pipe section is jacked forward, control system shall synchronize all of operational functions of system.
- 4. Active Direction Control. Provide MTBM which includes active direction control system with following features:
 - a. Controls line and grade by guidance system that relates actual position of MTBM to design reference (e.g., by laser beam transmitted from jacking shaft along pipe to target mounted in shield).
 - b. Provides active steering information which shall be monitored and transmitted to operating console.
 - c. Provides positioning and operation information to operator on control console.
- 5. Use generator which is suitably insulated for noise (“hospital” type) in

residential or commercial areas.

- G. Pipe Jacking Equipment. Provide pipe jacking system with following features:
1. Has main jacks mounted in jacking frame located in starting shaft.
 2. Has jacking frame which successively pushes string of connected pipes following tunneling excavation equipment towards receiving shaft.
 3. Has sufficient jacking capacity to push tunneling excavation equipment and string of pipe through ground. Incorporates intermediate jacking stations, if required.
 4. Has capacity at least 20 percent greater than calculated maximum jacking load.
 5. Develops uniform distribution of jacking forces on end of pipe by use of spreader rings and packing, measured by operating gauges.
 6. Provides and maintains pipe lubrication system at all times to lower friction developed on surface of pipe during jacking.
 7. Jack Thrust Reactions. Use reactions for pipe jacking that are adequate to support jacking pressure developed by main jacking system. Special care shall be taken when setting pipe guide rails in jacking shaft to ensure correctness of alignment, grade, and stability.
- H. Air Quality. Provide equipment to maintain proper air quality of manned tunnel operations during construction in accordance with OSHA requirements.
- I. Enclose lighting fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting, and other equipment.
- J. Electrical systems shall conform to requirements of National Electrical Code - NFPA70.

3.4 PIPE-JACKED TUNNELING DATA

- A. Maintain shift logs of construction events and observations. Engineer shall have access to all logs with regard to following information:
1. Location of boring machine face or shield by station and progress of tunnel drive during shift.
 2. Hours worked per shift on tunneling operations.

3. Completed field forms, such as steering control logs, for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment.
4. Maximum pipe jacking pressures per drive.
5. Location, elevation and brief soil descriptions of soil strata.
6. Ground water control operations and piezometric levels.
7. Observation of any lost ground or other ground movement.
8. Any unusual conditions or events.
9. Reasons for operational shutdown in event drive are halted.

3.5 EXCAVATION AND JACKING OF PIPE

A. Tunnel Excavation.

1. Keep tunnel excavation within easements and rights-of-way indicated on Drawings and to lines and grades designated on Drawings.
2. Perform tunneling operations in manner that will minimize movement of ground in front of and surrounding tunnel. Prevent damage to structures and utilities above and in vicinity of tunneling operations.
3. Open-face excavations:
 - a. Keep face breasted or otherwise supported and prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.
 - b. During shut-down periods, support face of excavation by positive means; no support shall rely solely on hydraulic pressure.
4. Closed-face excavation:
 - a. Carefully control volume of spoil removed. Advance rate and excavation rate to be compatible to avoid over excavation or loss of ground.
 - b. When cutting head is withdrawn or is open for any purpose, keep excavated face supported and stabilized.

5. Excavated diameter should be minimum size to permit pipe installation by jacking with allowance for bentonite injection into annular space.
6. Whenever there is condition encountered which could endanger tunnel excavation or adjacent structures, operate without intermission including 24-hour working, weekends and holidays, until condition no longer exists.
7. Assume responsibility for damage due to settlement from any construction-induced activities.

B. Pipe Jacking

1. Cushion pipe joints as necessary to transmit jacking forces without damage to pipe or pipe joints.
2. Maintain envelope of bentonite slurry around exterior of pipe during jacking and excavation operation to reduce exterior friction and possibility of pipe seizing in place.
3. If pipe seizes up in place and elect to construct recovery access shaft, obtain approval from Engineer. Coordinate traffic control measures and utility adjustments as necessary prior to commencing work.
4. In event section of pipe is damaged during jacking operation, or joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, submit for approval his methods for repair or replacement of pipe.

C. Grouting. Grouting requirements are defined in Section 02431 - Tunnel Grout.

3.6 CONTROL OF LINE AND GRADE

A. Construction Control.

1. Engineer will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report any errors or discrepancies to Engineer.
2. Use baselines and benchmarks established by Engineer to establish and maintain construction control points, reference lines and grades for locating tunnel, sewer pipe, and structures.
3. Establish construction control points sufficiently far from work so as not to be affected by ground movement caused by pipe-jacked tunneling

operations.

- B. Bench Mark Movement. Ensure that if settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks detect and report such movement and reestablish temporary bench marks.
- C. Line and Grade.
 - 1. Check and record survey control for tunnel against above-ground undisturbed reference at least once for each 250 feet of tunnel constructed.
 - 2. Record exact position of MTBM or TBM or shield after each shove to ensure alignment is within specified tolerances. Make immediate correction to alignment before allowable tolerances are exceeded.
 - 3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.
 - 4. Acceptance criteria for sewer pipe shall be plus or minus 6 inches in horizontal alignment from theoretical at any point between manholes, including receiving end, and plus or minus 1-1/2 inches in elevation from theoretical.
 - 5. Pipe installed outside tolerances and subsequently abandoned shall first be fully grouted.

3.7 MONITORING

- A. Instrumentation Monitoring. Instrumentation requirements are shown on Drawings. Instrumentation specified shall be accessible at all times to Engineer. Readings shall be submitted promptly to Engineer.
 - 1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control points at distance from construction areas that avoids disturbance due to ground settlement.
 - 2. Installation of instrumentation shall not preclude Engineer, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Access shall be provided to work for such independent installations.
 - 3. Instruments shall be installed in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring

1. Establish monitoring points on all critical structures.
2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.
3. Ground surface elevations shall be recorded on centerline ahead of tunneling operations at minimum of 100-foot intervals or at least three locations per tunnel drive. For sewers greater than 60-inch diameter, also record similar data at approximately 20 feet each side of centerline. Settlement monitoring points must be clearly marked by studs or paint for ease of locating.
4. Railroads. Monitor ground settlement of track subbase at centerline of each track.
5. Utilities and Pipelines. Monitor ground settlement directly above and 10 feet before and after utility or pipeline intersection.

C. Reading Frequency and Reporting. Submit to Engineer, records of readings from various instruments and survey points.

1. Instrumentation monitoring results to be read at frequency specified and unless otherwise specified, shall be started prior to zone of active excavation reaching that point, and shall be continued until zone of active excavation has passed and until no further detectable movement occurs.
2. Surface settlement monitoring readings shall be taken:
 - a. Prior to zone of active excavation reaching that point
 - b. When tunnel face reaches monitoring point (in plan)
 - c. When zone of active excavation has passed and no further movement is detected.
3. All monitoring readings shall be submitted promptly to Engineer.
4. Immediately report to Engineer any movement, cracking, or settlement which is detected.

5. Following substantial completion but prior to final completion, make final survey of all monitoring points.

3.8 DISPOSAL OF EXCESS MATERIAL

- A. Remove spoil in accordance with Section 01576 - Waste Material Disposal.

3.9 ACCEPTANCE TESTING

- A. Acceptance testing is to be carried out by methods described in Section 02533 - Acceptance Testing For Sanitary Sewer.

END OF SECTION

Section 02447

AUGERING PIPE AND CONDUIT

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Installing water service pipe by methods of augering or casing by jacking and boring.
- B. Installing Telecommunication Conduit along or under Public Ways.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. No separate payment will be made for augering pipe for water lines under this Section. Include payment in unit price for Section 02511 - Water Lines.
 - 2. When open-cut construction is requested by Contractor for his convenience in areas designated for augering, and when approved in advance by Engineer, such areas shall be paid for at Unit Price for Section 02511 - Water Lines.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

- A. Auger Method: Installation of steel casing by excavating soil at advancing end of casing and transporting spoil through casing by otherwise uncased auger, while advancing casing by jacking at same rate as auger excavation progresses.
- B. Slurry Auger Method: Installation of casing or pipe by first drilling small diameter pilot hole from pit to pit, followed by removing excess soil and installing pipe or conduit by pull-back or jacking method.

1.04 REFERENCE STANDARDS

- A. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
- B. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
- C. ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.

- D. ASTM D 790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.05 REGULATORY REQUIREMENTS

- A. Conform to TxDOT permit requirements for installations under state highways. Authority will obtain required permits for State Highway crossings.
- B. Installations Under Railroads:
 - 1. Secure and comply with requirements of right-of-entry for crossing railroad company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.
 - 2. Use auger method only.
 - 3. Damages due to delays caused by railroad requesting work to be done at hours which will not inconvenience railroad will be at no additional cost to Authority.
 - 4. Maintain equipment and excavations at minimum 35-foot clearance from centerline of tracks.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for casing insulators, spacing of insulators for specific pipe, and location on project.
- C. Prior to installation of pits, obtain Engineer's approval for pit locations, size, depth, and areas for storage, material, and spoil handling. Acceptance by Engineer does not relieve Contractor from responsibility to obtain specified results.
- D. Show actual pit locations dimensioned on as-built drawings so that they can be identified in field.
- E. Submit copy of executed railroad company rights-of-entry to Engineer.
- F. Technical information on solid temporary plug as noted in Paragraph 3.02D.
- G. Survey data for settlement monitoring as noted in Paragraph 3.10.

1.07 CRITERIA FOR SELECTION OF MATERIAL

- A. Contractor shall be responsible for selection of casing, pipe, and pipe joints to carry anticipated thrust of jacks or loads.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Piping and Fittings: As required by Specification or Drawings.
- B. Casings: Where shown on Drawings, in accordance with Section 02502 - Steel Pipe and Fittings.
- C. Casing Spacers: Where casings are shown on Drawings, use casing spacer width of 8 inches for pipe sizes 4 to 12 inches; 12 inches for pipe sizes 14 inches and larger. Wood skids or concrete donuts are not acceptable.
 - 1. For welded steel pipe 12 inches and smaller, use Pipeline Seal & Insulator Model PE, Advance Products & Systems Model CI, or approved equal.
 - 2. For other pipe materials, use Pipeline Seal & Insulator Model C8G-2, Advance Products & Systems Model S18-2, or approved equal for pipe sizes up to 12 inches.
 - 3. For all pipe sizes above 12 inches, use Pipeline Seal & Insulator Model C12G-2, Advance Products & Systems SI12-2, or approved equal.
 - 4. Obtain approval for equal product in writing from Engineer prior to bid.
 - 5. Use ISO-9002 registered casing spacer manufacturer or supplier. Submit copy of current certificate with submittal package.
- D. Casing End Seals: Provide Pipeline Seal and Insulator Model C, Advance Products & Systems Model AC, or approved equal.
- E. Casing Spacers (for Pipe Diameters 16 Inches or Greater): Bolt-on style with shell made of two sections of 14-gauge carbon steel, hot rolled, cleaned, and lined with PVC liner, 0.090 inch thick with Durometer A 85-90 overlapping edges to secure liner to spacer; deep embossed flanges for added strength; coated prior to installation of liner and runner with fusion-bonded PVC powder of 14 to 20 mils thickness; electroplated studs, nuts, and washers.
 - 1. Runners (for Pipe Diameters 16 Inches or Greater): Supported by 10-gauge carbon steel MIG risers welded to shell. Total length of weld beads shall be at least 50 percent of the length of the runner. Fill bolt holes with caulk or approved equal to provide a watertight seal. Minimum requirements: glass reinforced plastic conforming to the following tests:
 - a. Tensile Strength: ASTM D 638; 17,600 psi.
 - b. Flexural Strength: ASTM D 790; 25,300 psi.
 - c. Compression Strength: ASTM D 695; 18,000 psi.

- d. Deflection Temperature at 264 psi: ASTM D 648; 405 F.
- e. Polyethylene runners are not acceptable.

PART 3 EXECUTION

3.01 LIMITS ON AUGER LENGTH WITHOUT CASING

- A. Do not exceed 100 feet for length of auger hole without receiving pit.
- B. Do not exceed 75 feet for length of auger hole for PVC pipe 12 inches and less in diameter without receiving pit.
- C. Do not exceed 100 feet for length of auger hole for PVC pipe 14 inches to 24 inches in diameter without receiving pit.

3.02 PREPARATION

- A. Conform to applicable provisions of Section 02233 - Clearing and Grubbing.
- B. Utility Relocations: Relocate utility lines clear of pit and zone of potential significant settlement or other ground disturbance.
- C. Install casings as required by Drawings, in accordance with this Section.
- D. Install temporary solid plug at open end of water line to prevent contamination.

3.03 TRAFFIC CONTROL

- A. Conform to applicable provisions of Section 01555 - Traffic Control and Regulation.
- B. Secure right-of-entry for crossing railroad company's easement or right-of-way.
- C. During construction operations, furnish and maintain barricades and lights to safeguard traffic and pedestrians, until such time as backfill has been completed and removed from site. Provide additional barricades and lights as directed by Project Manager.

3.04 PITS

- A. Construct pits on segments of line and within right-of-way. Locate auger pits where there is minimum interference with traffic or access to property. Avoid locating pits close to storm drainage channels, ditches, storm water lines, culverts, or near potentially contaminated areas.
- B. Pit Size: Size pits to provide adequate room to meet operational requirements for auger construction as well as structures indicated on Drawings. Provide minimum 6-inch space between pipe and walls of auger pit. Maximum allowable width of pit shall be 5 feet. Width of pit at surface shall not be less than at bottom. Maximum allowable length of pit

shall be no more than 5 feet longer than one full section of pipe and shall not exceed 25 feet.

- C. Excavate bore pits to finished grade at least 6 inches lower than grade indicated by stakes.
- D. Backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.
- E. Auger pits that are excavated and backfilled as part of open-cut water line construction shall be in accordance with Section 02317 - Excavation and Backfill for Utilities.
- F. Provide and properly maintain safety protection against traffic, and accidental or unauthorized entry. Provisions to include concrete traffic barriers or other suitable barrier around periphery of pit. Fully cover and secure pits where no construction activity is in progress.
- G. Install sheeting, lining, shoring, and bracing required for protection of workmen and public in accordance with Section 02260 - Trench Safety Systems.
- H. Provide groundwater control and drainage from pits while work is in progress and until pit is properly backfilled. Conform to requirements of Section 01578 - Control of Groundwater and Surface Water.

3.05 AUGERING (BORING)

- A. Auger from approved pit locations. Excavate for pits and install shoring as outlined above under Paragraph 3.04, Pits. Drill small diameter pilot hole entire length of crossing and check for line and grade. Diameter of auger hole not to exceed pipe bell diameter plus 2 inches. Place excavated material outside working pit and dispose of as specified. Use water or other fluids in connection with boring operation only to lubricate cuttings; jetting is not permitted.
- B. In unconsolidated soil formations, gel-forming colloidal drilling fluid may be used. Fluid is to consist of at least 10 percent of high-grade processed bentonite and shall consolidate cuttings of bit, seal walls of hole, and shall furnish lubrication for subsequent removal of cuttings and installation of pipe.
- C. Depending on character of soil encountered during augering operation, conduct operations without interruption, insofar as practical, to prevent hole from collapsing or pipe from seizing up in hole before installation is complete.
- D. Allowable variation from line and grade shall be as specified under Paragraph 3.08, Jacking.
- E. Remove and replace pipe damaged in augering operations.

3.06 AUGERING OF CASING

- A. Provide jacks, mounted on frame or against backstop, of capacity suitable for forcing excavating auger and casing through soil conditions to be encountered. Operate jacks so that even pressure is applied to casing.
- B. Provide steerable front section of casing to allow vertical grade adjustments. Provide water level or other means to allow monitoring of grade elevation of auger casing.
- C. Bentonite slurry may be used to lubricate casing during installation. Use of water to facilitate removal of spoil and to lubricate exterior casing is permitted; however, water jetting for excavation of soil is not allowed when jacking casing.
- D. Tolerances from lines and grades shown on Drawings for gravity sewer pipe installed in casing are plus or minus 6 inches in horizontal alignment, and plus or minus 1-1/2 inches in elevation.

3.07 FILLING ANNULAR SPACE

- A. For installation of water line, block void space around pipe in augered hole with approximately 12 inches of packed clay or approved equal material to prevent bedding or backfill from entering void around pipe in augered hole when compacted. For pipe diameters 4 inches through 8 inches use minimum 1/2-cubic-foot clay; for pipe diameters 12 inches through 16 inches use minimum 3/4-cubic-foot clay.

3.08 JACKING

- A. Comply with Section 02260 - Trench Safety for all pits, end trenches, and other excavations relating to work required by specifications. Dewater as required to provide safe working conditions.
- B. Wherever end trenches are cut into sides of embankment or beyond it, sheath securely and brace such work to prevent earth caving.
- C. Make up only one joint at time in pit or trench prior to jacking.
- D. Do not interfere with operation of railroad, street, highway, or other facility, nor to weaken or damage embankment or structure.
- E. Use heavy-duty jacks sized for forcing casing through embankment. Use appropriate jacking head, usually of timber, and bracing between jacks and jacking head and jacking frame or backstop. Apply jacking pressure uniformly around ring of casing. Set casing to be jacked on guides, properly braced together, to support section of casing and to direct it in proper line and grade. Place jacking assembly in line with direction and grade of casing. Excavate embankment material just ahead of casing and remove material through casing. Force casing through embankment with jacks into excavated auger hole.
- F. Conform excavation for underside of casing to contour and grade of casing, for at least one third of circumference of casing. Provide clearance of not more than 2 inches for upper half of casing. Taper off upper clearance to zero at point where excavation conforms to contour of casing.

- G. Excavation may extend beyond end of casing depending on character of material, but shall not exceed 2 feet. Decrease advance excavation at direction of Engineer, when character of material being excavated makes it desirable to keep advance excavation closer to end of casing.
- H. Jack casing from low or downstream end. Lateral or vertical variation in final position of casing from line and grade as shown on Drawings will be permitted only to extent of 1 inch in 10 feet, provided such variation is regular and only in one direction and that final grade of flow line is in direction indicated on Drawings.
- I. Use cutting edge of steel plate around head end of casing extending short distance beyond end of casing with inside angles or lugs to keep cutting edge from slipping back onto casing.
- J. Once jacking of casing is begun, carry on without interruption, insofar as practicable, to prevent casing from becoming firmly set in embankment.
- K. Remove and replace casing damaged in jacking operations.
- L. Backfill pits or trenches excavated to facilitate jacking operations immediately after completion of jacking of casing.
- M. Grout annular space between casing and excavated hole when loss of embankment occurs or when clearance of 2 inches is exceeded.

3.09 SPACER INSTALLATION

- A. There must be no inadvertent metallic contact between casing and carrier pipe. Place spacers to ensure that carrier pipe is adequately supported throughout length, particularly at ends, to offset settling and possible electrical shorting unless otherwise approved by Authority. Place end spacer within 6 inches of end of casing pipe, regardless of size of casing and carrier pipe or type of spacer used. Spacing between spacers depends largely on load bearing capabilities of pipe coating and flexibility of pipe.
- B. Grade bottom of trench adjacent to each end of casing to provide firm, uniform, and continuous support for carrier pipe. When trench requires some backfill to establish final trench bottom grade, place backfill material in 6-inch lifts and compact to density of undisturbed soil.
- C. Install casing spacers in accordance with manufacturer's instructions. Take special care to ensure that sub-components are correctly assembled and evenly tightened, and that no damage occurs during tightening of insulators or carrier pipe insertion.
- D. Seal annulus between carrier pipe and casing with casing end seals at each end of casing.
- E. Insulator Spacing:
 - 1. Spacing shall be as shown on Drawings with maximum distance between spacers to be 10 feet for pipe sizes 4 to 14 inches and 8 feet for pipe sizes 16 to 30 inches.

2. For ductile iron pipe or bell-and-spigot pipe, install spacers within one foot on each side of bell or flange and one in center of joint when 18- to 20-foot-long joints are used.
3. If casing or carrier pipe is angled, bent, or dented, reduce spacing as directed by Engineer. Provide casing with smooth, continuous interior surface.

3.10 SETTLEMENT MONITORING

- A. Monitor ground surface elevation along length of augering operation. Locate and record settlement monitoring points with respect to construction baseline and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location.
 1. Railroads: Track subbase at centerline of each track.
 2. Product Pipelines: Directly above and 10 feet before and after pipeline intersection.
- B. Reading Frequency and Reporting. Take settlement survey readings:
 1. Prior to auger excavation reaching point.
 2. After auger reaches monitoring point in plan.
 3. After grouting of ground supporting casing is complete.
- C. Immediately report to Engineer movement, cracking, or settlement which is detected.
- D. Following substantial completion but prior to final completion, make final survey of monitoring points.

3.11 DISPOSAL OF EXCESS MATERIAL

- A. Conform to applicable provisions of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02448

PIPE AND CASING AUGERING FOR SEWERS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Installation of casing for sewer pipe by dry angering or slurry boring methods, together with installation of sewer pipe in casing.
- B. Installation of sewer pipe by slurry boring methods. Construction casing may be used at Contractor's option.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Casing, including sewer pipe, installed by augering methods in mid-run of open cut segments where shown on Drawings, will be measured and paid by linear foot from end-to-end of casing. Casing may be installed, at Contractor's option, at locations other than shown on Drawings, at no additional cost to the Authority.
 - 2. Sewer pipe installed by augering methods in mid-run of open-cut segments where shown on Drawings, will be measured and paid by linear foot from end to end of augered section.
 - 3. Pipe or casing segments installed by augering methods in locations other than mid-run of open cut segments and shown on Drawings, will be measured and paid by linear foot along centerline of completed sewer from centerline to centerline of manholes to ends of stubs or termination of pipe, and to inside face of lift stations and other structures.
 - 4. Payment will include and be full compensation for labor, equipment, materials and supervision for excavation and construction of sewer, complete in place including disposal of excess materials, shoring, dewatering, utility adjustments, grouting, backfill, clean-up, and other related work necessary for construction as indicated on Drawings and specified in this Section.
 - 5. Cost for pits and other excavations are included in unit price for pipe with or without casing.
 - 6. Trench safety systems for pits are paid as specified in Section 02260 - Trench Safety Systems.
 - 7. Refer to Section 01270 -Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

- A. Augering means either "dry augering" or "slurry augering".
- B. Dry augering is jacking casing while excavating soil at heading and transporting spoil back through casing by otherwise uncased auger.
- C. Slurry Auger Method: Installation of casing or pipe by first drilling small diameter pilot hole from shaft to shaft, followed by removing excess soil and installing pipe or conduit by pull back or jacking method.

1.04 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.
- B. American Association of State Highway and Transportation Officials (AASHTO).

1.05 REGULATORY REQUIREMENTS

- A. Conform to Texas Department of Transportation for installations under state highways. Authority will obtain required permits for state highway crossings.
- B. Installations under Railroads:
 - 1. Secure and comply with requirements of right-of-entry for crossing railroad company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.
 - 2. Use dry auger method only.
 - 3. Damages due to delays caused by railroad requesting work to be done at hours which will not inconvenience the railroad will be at no additional cost to Authority.
 - 4. Maintain minimum 35-foot clearance from centerline of tracks.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. For installation by augering, submit for review:
 - 1. Description of mechanized excavating equipment.

2. Method of controlling line and grade.
 3. Grouting techniques to be used for filling annular void between sewer pipe and casing, and void between sewer pipe or casing and ground, including equipment, pumping and injection procedures, pressure grout types, and mixes.
 4. Locations and dimensions of pits.
 5. Pit design and construction drawings.
 6. Identification of casings required and paid under Contract and casings installed at Contractor's option.
 7. Design of casings.
 8. Copy of railroad company permits and right-of-entry.
- C. Prepare auger pit and casing design submittals that are site specific. Have auger pit and casing design submittals signed and sealed by qualified Professional Engineer registered in State of Texas.
- D. Include in construction phase submittals:
1. Daily logs of augering and boring operations.
 2. Settlement monitoring data to meet requirements of paragraph 3.05, Settlement Monitoring.
 3. Submit daily logs and settlement monitoring data within 5 days after day of observation.

1.07 CRITERIA FOR DETERMINING CASING INSTALLATION LOADS

- A. Select and design casing pipe and pipe joints to carry thrust of jacks or loads due to pulling mechanism in combination with overburden, earth and hydrostatic loads. Select casings for dry augering to withstand action of auger without damage.
- B. Use Professional Engineer to determine design stresses, design deflections, and factors of safety for design of casing. Present such determination as part of design submittal. Apply the following maximum casing pipe stresses and deflections to casings shown on Drawings:
1. Design stress in pipe wall: 50 percent of minimum yield point of steel or 18,000 psi, whichever is less, when subjected to applicable loading conditions.
 2. Wall thickness: Maximum allowable deflection which does not exceed 3 percent of nominal casing diameter.

- C. Use Cooper E-80 locomotive loading distributions as criteria for railroad crossings in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks.
- D. Use H-20 vehicle loading distributions as criteria for truck loading in accordance with AASHTO.
- E. When not specifically indicated on Drawings, select casing diameter to permit practical installation (including skids when applicable) and grouting.

PART 2 P R O D U C T

2.01 MATERIALS

- A. Provide casing pipe which is straight, circular in section, uncoated, welded steel pipe, in accordance with Section 02502 - Steel Pipe and Fittings.
- B. Provide sewer pipe in accordance with Section 02531 - Gravity Sanitary Sewers. Do not use high density polyethylene pipe for augering.
- C. Provide restrained joint sewer pipe when installing sewer pipe in slurry bored holes by pullback method.
- D. Supply grout as specified in Section 02431 - Tunnel Grout.

PART3 EXECUTION

3.01 LOCATION AND SIZE OF AUGER PITS

- A. Show location of auger pits on auger pit construction drawings. Locate auger pits for slurry boring so that distance between pits is no greater than 80 feet; and for dry augering not more than 120 feet apart.
- B. Locate auger pits and associated work areas to avoid blocking driveways and cross streets and to minimize disruption to business and commercial interests. Avoid auger pit locations near areas identified as potentially contaminated.
- C. Make size adequate for construction of structures indicated on Drawings. Provide adequate room to meet Contractor's operational requirements for augering.
- D. Provide portable concrete traffic barriers around periphery of pit, meeting applicable safety standards. Properly maintain barriers throughout period pit remains open. Angle traffic barriers in direction of lane flow; do not place barriers perpendicular to on-coming traffic.

- E. Provide full cover or other security fencing for each access pit in which there is no construction activity or which is unattended by Contractor's personnel.

3.02 DRY AUGERING OF CASING

- A. Provide jacks, mounted on frame or against backstop, of capacity suitable for forcing excavating auger and casing through soil conditions to be encountered. Operate jacks so that even pressure is applied to casing.
- B. Provide steerable front section of casing to allow vertical grade adjustments. Provide water level or other means to allow monitoring of grade elevation of auger casing.
- C. Bentonite slurry may be used to lubricate casing during installation. Use of water to facilitate removal of spoil is permitted; however, water jetting for excavation of soil is not allowed when jacking casing.
- D. Tolerances from lines and grades shown on Drawings for gravity sewer pipe installed in casing are plus or minus 6 inches in horizontal alignment, and plus or minus 1-1/2 inches in elevation.

3.03 SLURRY BORING OF CASING OR PIPE

- A. Drill small diameter pilot hole and check for line and grade at receiving end. Redrill pilot hole when bored pipe does not meet specified tolerances.
- B. Using pilot hole as guide bore larger diameter hole of sufficient size for pipe or casing installation. Water jetting is not permitted.
- C. Bentonite slurry may be used to maintain stable hole and furnish lubrication for pipe or casing installation.
- D. Tolerances from lines and grades shown on Drawings for installed sewer pipe are plus or minus 6 inches in horizontal alignment and plus or minus 1-1/2 inches in elevation.
- E. Completely fill annular space between sewer pipe and surrounding soil or casing and surrounding soil with grout, without displacing pipe during grouting operation.

3.04 SEWER PIPE IN CASING

- A. Grout annular void between sewer pipe and casing from end-to-end of casing. Block and brace sewer pipe to prevent movement during grout placement and to maintain specified line and grade. Grout as specified in Section 02431 - Tunnel Grout.

3.05 SETTLEMENT MONITORING

- A. Monitor ground surface elevation along length of augering operation. Locate and record settlement monitoring points with respect to construction baseline and

elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences. At minimum, locate survey points as follows:

1. For road crossings: Centerline and each shoulder.
 2. Railroads: Track subbase at centerline of each track.
 3. Utilities and Pipelines: Directly above and 10 feet before and after utility or pipeline intersection.
 4. Long bores under improved areas such as pavements: Ground surface elevations must be recorded on centerline ahead of augering operations at locations not to exceed 50 feet apart (including points located for roads, railroads, utilities, and pipelines), or at least three locations per augering drive.
- B. Reading Frequency and Reporting. Take settlement survey readings at monitoring point locations:
1. Prior to auger excavation.
 2. After auger reaches monitoring point.
 3. After grouting annular space between surrounding soil and sewer pipe or casing is complete.
- C. Immediately report to the Engineer movement, cracking, or settlement which is detected.
- D. Following substantial completion, but prior to final completion, make final survey of monitoring points.

3.06 DISPOSAL OF EXCESS MATERIAL

- A. Remove and dispose of excess material (vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage) from job site in accordance with Section 01576 - Waste Material Disposal.

3.07 LEAKAGE TESTING

- A. Test sanitary sewers for leakage by low pressure air methods in accordance with Section 02533 – Acceptance Testing for Sanitary Sewer.

END OF SECTION

Section 02464

SPECIAL SHORING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Furnishing and installing a special shoring system in order to prevent ground movements and protect adjacent existing installation or improvements such as structures and utilities. Special shoring methods may include steel sheet piling with interlocking joints, soldier structural sheet piling with lagging, or other method proposed by Contractor and approved by Engineer for location and limits shown on Drawings.
- B. Perform driving and extraction of sheet piling by specialized systems that minimize noise, ground vibrations and displacements that may harmfully affect adjacent structures, buildings, and underground utilities. Soldier piling may also be used provided that requirements of this Section are met.
- C. Remove special shoring after work is completed unless otherwise shown on Drawings.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for special shoring will be on a linear foot basis at locations shown on Drawings and as listed in Exhibit 1 – Contractor’s Bid. Measurement will be along centerline of proposed water line. Payment includes labor, materials, equipment, handling, storing, cutting, splicing, driving, structural steel lateral bracing, ground movement monitoring program, additional soil investigation, and groundwater control to install special shoring system, complete in place as designed by Contractor’s Engineer. Payment also includes labor, material and equipment to remove or abandon special shoring as shown on Drawings.
 - 2. Refer to Section 02260 – Trench Safety System for measurement and payment of trench safety system.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. AISC Steel Construction Manual
- B. ASTM A36 – Standard Specification for Carbon Structural Steel
- C. ASTM A572 Grade 50 – Steel Sheet Piling.
- D. AWS D1.1 – Structural Welding Code.
- E. Occupational Safety and Health Administration (OSHA).

1.04 RELATED SECTIONS

- A. 01576 – Waste Material Disposal
- B. 01578 – Control of Groundwater and Surface Water
- C. 02260 – Trench Safety System.
- D. 02317 – Excavation and Backfill for Utilities
- E. 02621 - Geotextile

1.05 DEFINITIONS

- A. Special Shoring – installed to prevent ground movements and protect adjacent installations or improvements such as structures, pavements or utilities. Special shoring may be interlocking steel sheet piling or other system as described herein and approved by Engineer.
- B. Interlocking Steel Sheet Piling – Steel sheet piles are long structural sections with a vertical interlocking system, that is internally braced as required, to create a continuous wall to retain soil.
- C. Soldier Piles with lagging – retains soil with vertical steel piles and horizontal lagging. H piles are driven along regular intervals, and lagging made of wood or steel is inserted behind the front pile flanges as the excavation continues. Additional lateral support may be added with anchors or bracing.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

- B. Shop Drawings and Engineering Calculation Submittal: Submit detailed drawings and calculations prepared, signed and sealed by a Professional Engineer licensed in the State of Texas.
 - 1. Shop drawings should include complete design for special shoring system including fabricated sections, complete piling dimensions and details, driving sequence and layout of installed piling. Include details of top protection, special reinforcing, lagging, splices, fabricated additions to plain piles, cut-off method, and dimensions of template and other temporary guide structures for installing piling.
 - 2. Provide details of the method for handling piling to prevent permanent deflection distortion or damage to piling interlocks.
 - 3. Calculations used to verify adequacy of system's strength capacity and ability to maintaining ground displacements within tolerance.
- C. Qualifications:
 - 1. Welder's Certificates: Submit records of welder's AWS qualifications within the previous 12 months.
 - 2. Special Shoring Installer: Submit qualification of trained personnel that can demonstrate the required experience in type of special shoring system to be employed.
- D. Affidavit of compliance: Submit affidavit from the manufacturer of special shoring that they conform to requirements of this Section.
- E. Installation Equipment: Records of completed special shoring operation including a system identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling.
- F. Equipment Literature: Descriptions of the pile driving equipment to be used on this Project. Include details of the pile hammer, power plant, cap block or hammer cushion, pile cap, pile cushion, leads, piles extractors and other installation appurtenances.
- G. Removal of Special Shoring: Provide information on the method of pulling or removing special shoring.
- H. Quality Control Plan: Submit for review a brief description of quality control methods including:

1. Procedures for surveying, controlling, and checking line and grade including field forms for establishing and checking line and grade.
2. Procedures for preparing and submitting daily pile installation logs.
3. Instrumentation plan showing locations and frequency of monitoring relative to critical structures within the zone of active excavation. Provide procedures, forms, and schedules for periodic submittals of readings.
4. Settlement survey plan (may be included in instrumentation plan).
5. Ground Movement Monitoring Plans:
 - a. Instrumentation Monitoring Plan: Monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.
 - b. Surface Settlement Monitoring Plan: Settlement monitoring plan identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.
6. Structures Assessment: Preconstruction and post-construction assessment reports for critical structures located within zone of active excavation. Include photographs or a video of existing damage to structures in vicinity.

1.07 FIELD MEASUREMENTS

- A. Employ Registered Professional Land Surveyor (Surveyor) to set up positions of piles as shown in pile layout plans. Accuracy and positioning of each pile is responsibility of Contractor. Preserve stakes set by surveyor. Stakes lost or missing must be restored by Surveyor. Upon completion of project, record layout of shoring on as-built drawings, verified by Surveyor.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Provide new and undamaged materials that are accompanied by certified test reports. Provide manufacturer's logo and mill identification mark on special shoring.
- B. Storage: Store as recommended by manufacturer. At minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Prevent corrosion prior to installation. Method of storage must facilitate required inspection.

- C. Handling: Use handling holes. Handle long length piles with care to prevent permanent deflection, distortion or damage to interlocks.

1.09 TRENCH SAFETY SYSTEM

- A. Special shoring is intended to protect existing structures. Contractor to provide trench safety system in accordance with Specification Section 02260 – Trench Safety System.

PART 2 P R O D U C T S

2.01 DESIGN CRITERIA

- A. Refer to Geotechnical Investigation Report for detailed soil information. Additional soil borings may be taken by Contractor.
- B. Groundwater Elevation: At ground level on the retained side of special shoring.
- C. Neglect cohesion for active pressure determination.
- D. Load surcharge shall be based on the actual construction equipment used, and no less than 300 psf surcharge pressure from construction equipment or soil stockpiles at top of special shoring.
- E. Factor of Safety of 2.0 for passive earth pressure in front of special shoring system.

2.02 MATERIALS

- A. Sheet piles: Hot-rolled sections conforming to ASTM A572/A572M, Grade 50. Interlocks to be free sliding, provide a swing angle suitable for the installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Provide full length section of dimensions shown, with square and blunt ends as received from mill or squarely cut. Provide with standard pulling holes.
 - 1. Minimum elastic section modulus: 30.2 cubic inches per foot wall
 - 2. Minimum thickness: 0.375 inches
- B. Welding: AWS D1.1
- C. Furnish materials from single manufacturer.
- D. Sheet piling and interlocks must be free of excessive kinks camber or twist that prevents free sliding of pile.

- E. Structural Steel Bracing: Steel plates and angles shall be ASTM A36 steel. Steel rolled shapes shall be ASTM A572 steel.
- F. Structural Steel for Soldier Piling: ASTM A572, Grade 50, HP or W section per AISC Steel Manual.
- G. Treated Timber Lagging: The minimum tabulated unit stress in bending (Fb): 1,000 psi
- H. Geotextile: Refer to Specification Section 02621 – Geotextile.

PART 3 EXECUTION

3.01 INSTALLATION OF SPECIAL SHORING

- A. Groundwater Control: Refer to Specification Section 01578 – Control of Groundwater and Surface Water.
- B. Install using methods as approved by Engineer that will minimize noise and prevent ground vibrations.
- C. Pile Protection: Use a protective cap during driving piling to prevent damage.
- D. Placing: Temporary wales, templates, or guide structures suitable for aligning, supporting and maintaining special shoring in the correct position during settling, and place and drive piles in the correct alignment. Use at least two templates in placing each piling with maximum spacing of templates not exceeding 20 feet. Provide templates with sufficient rigidity to resist lateral and driving forces without movement, and to adequately support the pilings until design tip elevation is achieved.
 - 1. Steel sheet piling: properly place and drive to form an interlock throughout the length with adjacent piles forming a continuous diaphragm throughout the length run of piling wall.
- E. Pile installation: Take adequate precautions to confirm piles are installed plumb. Install individual pilings in sequential order in depth increments until final depth is achieved. Tip of a sheet pile shall not be more than 4 feet below the tip of the adjacent piling. Remove piles damaged during installation or out of interlock and replace.
- F. Splices: Extend sheet piles driven below required top elevation and sheet piles damaged by driving and cut off to permit further driving. If necessary, splice pilings to be driven to greater depth than shown and extended upward to the required elevation. Provide full length pilings adjoining spliced pilings unless otherwise approved. Square ends of pilings before splicing to avoid dips or camber. Splice with concentric alignment of interlocks so there is no discontinuity, dips or camber at the

abutting interlocks. Splice pilings to be free-sliding and able to obtain maximum swing with contiguous pilings. Trim tops of pilings that are excessively damaged. Remove piling cut offs from site.

- G. Holes: Cut holes in pilings for bolts, rods or utilities in a neat, workman-like manner. Holes may be burned or reamed by methods that does not damage surrounding steel. Use a straight edge in cuts made by burning to avoid nicks.
- H. Welding: Perform welding of special shoring with a low hydrogen type electrode in accordance with Structural Welding Code AWS D1.1. Butt-weld splices. Deposit weld material with similar atmospheric corrosion resistance as base material. Splicing of two consecutive piles not permitted. Perform shop and field welding, qualification of welding procedures, welders, and welding operators in accordance with AWS D1.1 for the type of welding required.
- I. Cut-offs: Sheet or soldier piles installed to refusal or to the point where additional penetration cannot be attained and extending above the top elevation shall be cut off to the required elevation. Cut off in clean, straight lines within the stated tolerances.
- J. Tolerances: Install sheet or soldier piles with a vertical tolerance of not more than 1/4 inch per foot and true to line. Place pile so that face is not more than 4 inches from vertical alignment at any point. Top of pile at elevation of cut off to be within 1/2 inches horizontally and 2 inches vertically of designed location. Do not manipulate piles to force into position. Check pile for heaves during driving. Reinstall piles that heave more than 1/4 inch, and reinstall heaved piles to the specified tip elevation.
- K. Inspection: Continuous inspection of pile installation to be provided by Contractor. Inspect all piles for conformance to tolerance requirement. Report nonconformance to Engineer. Inspect interlocking of joints while extended above ground. Sheet piling found to be damaged beyond usefulness or out of interlock to be removed and replaced at no additional cost to Authority.

3.02 REMOVAL

- A. Pulling: Provide pull holes as required and extractors of suitable type and size. Exercise care in pulling pilings to avoid damaging piling interlocks as well as adjacent construction, existing structures, and underground utilities. If damage to adjacent structures or utilities has occurred, Contractor must repair at no additional cost to Authority. Pull one sheet at a time.

3.03 ABANDON IN PLACE

- A. Where shown on Drawings, shoring to be abandoned in place must be removed to 4 feet below ground surface. Where shoring is abandoned in place, show limits and depths on Record Drawings.

3.04 FIELD QUALITY CONTROL

- A. Maintain a record for special shoring installation. Record date, time, type and size of equipment, rate of operation, total installation time, pile locations, tip elevations, ground elevations, cut off elevations, and re-heading or cutting of piles.

3.05 MONITORING

- A. Instrumentation Monitoring. Install instrumentation system as per Contractor's monitoring plan. Provide access to instrumentation for Engineer at all times and submit readings to Engineer.
 - 1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control points at a distance from the construction areas that avoids disturbance due to ground settlement.
 - 2. Other independent instrumentation systems may be installed by others.
 - 3. Install in accordance with instrumentation manufacturer's recommendations.
- B. Surface Settlement Monitoring.
 - 1. Establish monitoring points on critical structures within zone of influence.
 - 2. Record settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Establish monitoring at locations and using methods that prevent damage from construction operations, tampering or other external influences.
 - 3. Utilities and pipelines: Monitor ground settlement directly above and 10 feet before and after the pipe utility crossing.
- C. Immediately report any ground settlement, cracking or movement that is detected to Engineer.
- D. Prior to final completion, provide final survey of all monitoring points and provide report to Engineer.

3.06 DISPOSAL OF EXCESS MATERIAL

- A. Conform to requirements of Section 01576 – Waste Material Disposal.

3.07 RECORD DRAWINGS

- A. Record on as-builts types and locations of special shoring left in place or abandoned.

END OF SECTION

Section 02501

DUCTILE IRON PIPE AND FITTINGS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Ductile iron pipe and fittings for water lines, wastewater force mains, gravity sanitary sewers, and storm sewers.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. No separate payment will be made for ductile iron pipe and fittings under this Section, with the exception of extra fittings in place. Include cost in unit prices for work as specified in the following Sections, as applicable:
 - a. Section 02511 - Water lines
 - b. Section 02531 - Gravity Sanitary Sewers
 - c. Section 02532 - Sanitary Sewage Force Mains
 - d. Section 02631 - Storm Sewers
- 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Extra Ductile Iron Compact Fittings in Place shall be for additional fittings required to complete job. This is not to exclude extension of pipe across driveway or intersection for purpose of terminating line in more advantageous position. This determination shall be at discretion of Engineer. This bid item includes additional fittings as may be necessary to complete job in conformance with intent of Drawings.

- C. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ANSI A 21.4 (AWWA C 104) - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, for Water.

- B. ANSI A 21.10 (AWWA C 110) - Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in.
- C. ANSI A 21.11 (AWWA C 111) - Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- D. ANSI A 21.15 (AWWA C 115) - Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
- E. ANSI A21.16 (AWWA C 116) - Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.
- F. ANSI A 21.50 (AWWA C 150) - Standard for Thickness Design of Ductile-Iron Pipe.
- G. ANSI A 21.51 (AWWA C 151) - Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids.
- H. ANSI A 21.53 (AWWA C 153) - Standard for Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.
- I. ANSI/AWS D11.2 –Guide for Welding Iron Castings
- J. ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- K. ASTM D 1248 - Standard Specification Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.
- L. ASTM F 477 - Elastomeric Seals (gaskets) for Joining Plastic Pipe.
- M. ASTM G 62 - Standard Test Methods for Holiday Detection in Pipeline Coatings.
- N. AWWA C 105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
- O. AWWA C150 – Thickness Design of Ductile-Iron Pipe.
- P. AWWA C 600 - Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
- Q. SSPC-SP 6 - Steel Structures Painting Council, Commercial Blast Cleaning.
- R. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.
- S. American Association of State Highway Transportation Officials (AASHTO).

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. For pipes 16 inches and greater, submit shop drawings signed and sealed by Professional Engineer registered in State of Texas showing the following:
 - 1. Manufacturer's pipe design calculations.
 - 2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, restrained joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Engineer. Provide final approved lay schedule in Adobe portable document format (*.PDF).
 - 3. Calculations and limits of thrust restraint shall be based on AWWA M41 or DIPRA Thrust Restraint for Ductile Iron Pipe, latest edition.
 - 4. Class and length of joint.
- C. Submit manufacturer's certifications that ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A 21.51.
- D. Submit certifications that pipe joints have been tested and meet requirements of ANSI A 21.11.
- E. Submit affidavit of compliance in accordance with ANSI A21.16 for fittings with fusion bonded epoxy coatings or linings.

PART 2 P R O D U C T S

2.1 DUCTILE IRON PIPE

- A. Ductile Iron Pipe Barrels: Shall conform to AWWA C115, C150 and C151 and bear mark of Underwriters' Laboratories approval. Provide minimum thickness Class 52 for sanitary sewers. Unless otherwise shown on Drawings, use a minimum Pressure Class 250 for water lines less than or equal to 20-inch diameter. For 24-inch and larger, design for project specific hydraulics as per AWWA C150. Use minimum Pressure Class 350 for water lines in casing or trenchless construction and for flanged

pipe.

- B. Provide pipe sections in standard lengths, not less than 18 feet long, except for special fittings and closure sections as indicated on shop drawings.
- C. For 24-inch and larger water lines, furnish and install cathodic protection in accordance with Section 13110 - Cathodic Protection System.
- D. For sanitary sewer lines, modify pipe for cathodic protection in accordance with Section 13110 - Cathodic Protection System. In lieu of furnishing ductile iron pipe with cathodic protection system, furnish ductile iron pipe with polyethylene encasement, provided the following criteria is met:
 - 1. Provide minimum thickness class.
 - 2. Provide polyethylene encasement material and install in accordance with Section 02528 – Polyethylene Wrap, and backfill as specified. Minimum of two complete wraps of 8-mil-thick polyethylene.
 - 3. Use polyethylene encasement for open cut installations only. For augered sections or sections installed inside a casing, provide coating in accordance with Paragraph 2.05 D.1.
 - 4. Adhere to other requirements specified herein (e.g., insulation kits, etc.).
- E. For use of pressure class pipe for water lines, design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading, AREMA E-80 loads and depths of bury as indicated on Drawings. Design pipes with Marston's earth loads for a transition width trench for zero to 16 feet of cover. Use Marston's earth loads for a trench width of O.D. (of pipe) + 4 feet for pipe greater than 16 feet of cover. Use Marston's equations for a trench condition in both open-cut and tunnel applications. Design for most critical groundwater level condition. Pipe design conditions:
 - 1. Working pressure = 150 psi.
 - 2. Hydrostatic field test pressure = 150 psi.
 - 3. Maximum pressure due to surge = 225 psi.
 - 4. Minimum Pressure due to surge = -10 psi.
 - 5. Design tensile stress due to surge or hydrostatic test pressure: No greater than 50% minimum yield.

6. Design bending stress due to combined earth loads and surge or hydrostatic test pressure: No greater than 48,000 psi.
 7. Unit weight of fill ≥ 120 pcf.
 8. Deflection lag factor (DI) = 1.2.
 9. Bedding constant (K) = 0.1.
 10. Moment coefficient = 0.16.
 11. Fully saturated soil conditions $hw=h$ =depth of cover above top of pipe.
- F. Hydrostatic Test of Pipe: AWWA C 151, Section 5.2.1, at point of manufacture. Hold test for a minimum 2 minutes for thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.
- G. Pipe Manufacturer for large diameter water lines: Minimum of 5 years of successful pipe installations in continuous service. Manufacturer must maintain on site or in plant enough fittings to satisfy the following requirements:

Line Diameter	Required Bends*
20 and 24 inches	Four 45°bends per 5,000 LF of water line
> 24 inches	Four 22.5°bends per 10,000 LF of water line
*Based on total length of contract (minimum of four). Any combination of bends may be substituted at manufacturer's option (i.e. two 22.5°bends are equivalent to one 45°bend) and will be counted as one fitting.	

Manufacturer or supplier must be capable of delivering bends to job site within 12 hours of notification. Use fittings at direction of Engineer where unforeseen obstacles are encountered during construction. These fittings are in addition to any fittings called out in construction documents and must be available at all times.

- H. Provide flange adapter with insulating kit as required when connecting new piping to existing piping and piping of different materials, unless otherwise approved by Engineer.
- I. Clearly mark pipe section to show location and thickness/pressure class color coded.

- J. No welding will be permitted on Ductile Iron Pipe except at restrained joint spigots or fittings as per ANSW/AWS D11.2. No field welding is allowed.

2.2 JOINTS

- A. Joint Types: ANSI A 21.11 push-on; ANSI A 21.11 mechanical joint; or ANSI A 21.16 flanged end. Provide push-on joints unless otherwise indicated on the Drawings or required by these specifications. For sanitary sewer lines with bolted joints, conform to requirements of AWWA C111; provide minimum 304 stainless steel for restraint joints. For water lines with bolted joints, conform to requirements of AWWA C111; provide Denso or approved equal petrolatum based tape coating system for exposed portion of nuts and bolts.
- B. Where required by Drawings, provide approved restrained joints for buried service. Refer to City of Houston's List of Approval Products for approved joint restraint mechanisms.
- C. Threaded or grooved-type joints which reduce pipe wall thickness below minimum required are not acceptable.
- D. Provide for restrained joints designed to meet test pressures required under Section 02515 - Hydrostatic Testing of Pipelines or Section 02532 - Sanitary Sewer Force Mains, as applicable. Provide restrained joints for test pressure or maximum surge pressure as specified, whichever is greater for water lines. Do not use passive resistance of soil in determining minimum restraint lengths.
- E. Electrical Bond Wires: Bond Wires; use stranded, copper cable furnished with high molecular weight polyethylene insulation (HMWPE). Use wire gauge (AWG) as shown on Drawings.
- F. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer for pipe joints or restraint joints. Submit details of other methods of providing curves and bends for consideration by Engineer. When other methods are deemed satisfactory, install at no additional cost to the Authority.

2.3 GASKETS

- A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material in accordance with ANSI A21.11 or ASTM F 477; for flanged joints 1/8-inch-thick gasket in accordance with ANSI A 21.15.
- B. For pipes to be installed in potentially contaminated areas, see Specification Section 02105 - Sampling and Analysis in PPCA.
- C. For Pipes to be installed in any other contaminated areas, use gaskets as recommended by the Pipe Manufacturer and the Engineer of Record and approved by

the Authority prior to installation.

2.4 FITTINGS

- A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they connect to.
- B. Push-on Fittings: ANSI A 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.
- C. Flanged Fittings: ANSI 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.
- D. Mechanical Joint Fittings: ANSI A 21.11; pressure rated at 250 psi.
- E. Ductile Iron Compact Fittings: Shall conform to AWWA C153 and shall be:
 - 1. Fusion bonded epoxy lined or
 - 2. Cement mortar lined.
- F. For tangential flanged outlets shown on Drawings, substitute with a tee with an equivalent sized outlet unless otherwise approved by Project Manager.

2.5 COATINGS AND LININGS

- A. Water line Interiors: ANSI A21.4, cement lined with seal coat; ANSI A 21.16 fusion bonded epoxy for interior; comply with NSF 61.
- B. Sanitary Sewer and Force Main Interiors:
 - 1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.
 - 2. Liner thickness: Nominal 40 mils, for pipe barrel interior; minimum 6 to 10 mils at gasket groove and outside spigot end to 6-inches back from end.
 - 3. Testing: ASTM G 62, Method B for voids and holidays; provide written certification.
 - 4. Acceptable Lining Materials:
 - a. Provide approved virgin polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage; heat bonded to interior surface of pipe and fittings.

- b. Ceramic Epoxy – Protecto 401 or approved equal.
- C. Sanitary Sewer Point Repair Pipe: For pipes which will be lined with high density polyethylene liner pipe or cured-in-place liner, provide cement-lined with seal coat in accordance with ANSI A 21.4. For pipes which will not be provided with named liner, provide pipe as specified in Paragraph 2.5B, Sanitary Sewer and Force Main Interiors.
- D. Exterior:
 - 1. Encasement and coating requirement for water lines
 - a. Open cut construction method:
 - 1) Provide double wrap polyethylene encasement applied in accordance with AWWA C105 or Section 02528 – Polyethylene Wrap.
 - 2) Provide Polyurethane coating in accordance with Section 02527 - Polyurethane Coatings on Steel or Ductile Iron Pipe.
 - b. Auger or casing construction method:
 - 1) Provide Polyurethane coating in accordance with Section 02527 - Polyurethane Coatings on Steel or Ductile Iron Pipe or
 - 2) Provide minimum thickness Class 52 pipe, double wrap with polyethylene encasement. Place circumferential wraps of tape or plastic tie straps at two-foot intervals along the barrel of the pipe, and thoroughly seal each end of the polyethylene tube.
 - c. Tunnel, Casing or Direct Bury: Conform to requirements of Paragraph 2.05E.
 - 2. Sanitary Sewers: Prime coat and outside asphaltic coating conforming to ANSI A21.10, ANSI A21.15, or ANSI A21.51 for pipe and fittings in open cut excavation and in casings.
- E. Polyethylene Wrap: For buried sanitary sewer pipes not cathodically protected, provide polyethylene wrap unless otherwise specified or shown. For water lines, provide polyethylene wrap unless otherwise specified or shown. Conform to requirements of Section 02528 - Polyethylene Wrap.
- F. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or equal, for the complete joint and alloy steel fasteners. Alternatively, sanitary sewer

lines may use bolts made of Type 304 stainless steel.

- G. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer for maximum resistance to the contaminants identified in the Phase II Environmental Site Assessment Report. If no alternative coating is specified for water lines, provide polyethylene wrap in potentially contaminated areas.

2.6 MANUFACTURERS

- A. Use pre-approved manufacturers listed in the City of Houston's Approved Products List.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Conform to installation requirements of Sections 02511 - Water Lines, 02531 - Gravity Sanitary Sewers, 02532 - Sanitary Sewer Force Mains 02631 - Storm Sewers and 02553 - Point Repairs and Obstruction Removal, except as modified in this Section.
- B. Install in accordance with AWWA C 600 and manufacturer's recommendations.
- C. Install double wrap polyethylene encasement in conformance with requirement of AWWA C105 and Section 02528 – Polyethylene Wrap.
- D. Holiday Testing.
 - 1. Polyurethane: Conform to requirements of Section 02527 - Polyurethane Coatings for Steel or Ductile Iron Pipe.
 - 2. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.
- E. Provide electrical continuity bonding across buried mechanical and push-on joint assemblies, except where insulating flanges are required by Drawings.
 - 1. Provide minimum number of bond wires shown on Drawings. Remove one inch of HMWPE insulation from each of bond wire prior to attaching.
 - 2. Secure wire onto pipe using approved Thermite Welding procedures.
 - 3. Coat bare metal and weld metal after weld is secure. Use coal-tar compound or other compatible coating. For polyurethane coated pipe, use compatible

polyurethane coating.

4. Visually inspect Thermite Weld connections for electrical continuity, strength and suitable coating prior to backfilling or placing pipe in augered hole or casing.

3.2 FIELD REPAIR OF COATINGS

- A. Polyurethane: Conform to requirements of Section 02527 - Polyurethane Coatings for Steel or Ductile Iron Pipe.
- B. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

END OF SECTION

Section 02502

STEEL PIPE AND FITTINGS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Steel pipe and fittings for water lines for aerial crossings, aboveground piping, and encasement sleeves. Do not bury steel pipe, unless it is large diameter water line.
- B. Specifications identify requirements for small-diameter less than or equal to 20 inches.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for steel pipe and fittings under this Section. Refer to Section 02511 - Water Lines for measurement and payment.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AASHTO - Standard Specifications for Highway Bridges.
- B. ASME B 16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
- C. ASTM A 36 - Standard Specification for Carbon Structural Steel.
- D. ASTM A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- E. ASTM A 105 - Standard Specification for Carbon Steel Pipe Forgings for Piping Applications
- F. ASTM A 106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

- G. ASTM A 135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
 - H. ASTM A 139 - Standard Specification for Electric-Fusion (ARC) - Welded Steel Pipe (NPS 4 and Over).
 - I. ASTM A 1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - J. ASTM D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - K. AWWA C 200 - Standard for Steel Water Pipe 6 in. and Larger.
 - L. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
 - M. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.
 - N. AWWA C 210 - Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - O. AWWA C 604 – Installation of Buried Steel Water Pipe – 4 In. and Larger.
 - P. AWWA M 11 – Steel Pipe – A Guide for Design and Installation.
 - O. SSPC Good Painting Practice, Volume 1.
 - P. SSPC SP 1 - Surface Preparation Specification No. 1 Solvent Cleaning.
 - Q. SSPC SP 5 - Joint Surface Preparation Standard White Blast Cleaning.
 - R. SSPC SP 6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.
 - S. SSPC SP 10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning.
 - T. SSPC VIS 1 - Visual Standard for Abrasive Blast Cleaned Steel.
- 1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 - Submittal Procedures. For aerial crossings and above ground piping, include 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.

- B. Submit manufacturer's certifications that pipe and fittings are new and unused.
- C. Submit manufacturer's certifications that pipe and fittings have been hydrostatically tested at factory in accordance with AWWA C 200.
- D. Submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section and:
 - 1. Polyurethane coatings were applied in strict accordance with manufacturer's recommendation and allowed to cure at temperature 5 degrees above dewpoint.
 - 2. Linings were applied and allowed to cure at temperature above 32 °F.
- E. Submit certification from NACE Certified Coatings Inspector, having Level III certification for coatings and linings, that steel pipe furnished on project was properly inspected and defective coatings detected were properly repaired.

1.5 QUALITY CONTROL

- A. Prior to start of work, provide proof of certification of qualification for welders employed for type of work, procedures and positions involved. Provide welder qualifications in accordance with AWWA C 206.
- B. Shop-applied coatings and linings; provide services of an independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Perform inspection by NACE trained inspectors under supervision of NACE Level III Certified Coatings Inspector verifying compliance with same requirements specified in Paragraph 3.02.
- C. Coatings: Measure temperature and dew point of ambient air before applying coatings. Inspect physical dimensions and overall condition of coatings. Inspect for visible surface defects, thickness, and adhesion of coating to surface and between layers.
- D. Final Inspection:
 - 1. Before shipment, inspect each finished pipe, fitting, special and accessory for markings, metal thickness, coating thickness, lining thickness (if shop applied), joint dimensions, and roundness.
 - 2. Inspect for coating placement and defects. Test exterior coating for holidays.

- a. Inspect linings for thickness, pitting, scarring, and adhesion.
- E. Ensure workmen engaged in manufacturing are qualified and experienced in performance of their specific duties.

PART 2 P R O D U C T S

2.1 STEEL PIPE

- A. Provide steel pipe and encasement sleeves designed and manufactured in conformance with AWWA C 200 and AWWA M 11 except as modified herein. Steel to be minimum of ASTM A106, ASTM A 36, ASTM A 1011 Grade 36, ASTM A 53 Grade B, ASTM A 135 Grade B, or ASTM A 139 Grade B.
- B. Minimum Allowable Steel-Wall Thickness:

CARRIER PIPE			
Nom. Pipe Size	Min.	Wall	Approx. Wt. Per L. F. Uncoated (Lb.)
	O.D (In.)	Thick. (In.)	
4	4.50	0.250	11.35
6	6.625	0.280	18.97
8	8.625	0.322	28.55
10	10.75	0.365	40.48
12	12.75	0.375	49.56
16	16.00	0.375	62.58
20	20.00	0.375	78.60

Notes for Carrier Pipe:

- 1. Review pipe and fitting design for conditions exceeding those specified herein.
- 2. Provide pipe with wall thickness of no less than listed in table above.

MINIMUM DIAMETER CASING PIPE (ENCASEMENT SLEEVES)			
Corresp. Casing Pipe Size (In.)	Min. Wall		Approx. Wt. Per L. F. Uncoated (Lb.)
	O.D. (In.)	Thick. (In.)	
8	8.625	0.219	19.64
10	10.75	0.219	24.60
12	12.75	0.219	29.28
16	16.00	0.219	36.86
18	18.00	0.250	47.39
20	20.00	0.250	52.73
24	24.00	0.250	63.41

Notes for Casing Pipe:

1. Provide casing pipe with wall thickness of no less than listed in table above.
 2. Casing pipe: AWWA C 200 new uncoated welded steel.
 3. Verify casing diameter required with dimensions of casing spacer.
- C. Provide pipe sections in lengths of no less than 16 feet except as required for special sections, and no greater than 40 feet.
- D. Provide short sections of steel pipe no less than 4 feet in length unless indicated on Drawings or specifically permitted by Engineer.
- E. Fittings: Factory forged for sizes 4 inches through 20 inches; long radius bends; beveled ends for field butt welding; wall thickness equal to or greater than pipe to which fitting is to be welded unless otherwise shown on Drawings.
- F. Joints:
1. Standard field joint for steel pipe and encasement sleeve: AWWA C 206. Single- welded, butt joint.
 2. Electrically isolate flanged joints between steel and cast iron by using flange isolation fittings as specified in paragraph 2.03 of Specification Section 15640 – Joint Bonding and Electrical Isolation. Use epoxy coated nuts and bolts to assemble the fittings.

3. Elbows to be standard weight seamless elbows per ASTM A106, Grade A or B.

G. Flanges: Refer to Specification Section 02511 – Water Lines.

2.2 INTERNAL LINING SYSTEMS FOR STEEL PIPE, ALL INSTALLATIONS

- A. Supply steel pipe with epoxy lining, capable of conveying water at temperatures not greater than 140 degrees F. Provide linings conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61 and certification to be from organization accredited by ANSI. Unless otherwise noted, coat exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, etc., with epoxy lining, as specified.
- B. Epoxy Lining AWWA C 210, White, or approved equal for shop and field applied, except as modified in this Section. Provide material from same manufacturer.

Surface Preparation as recommended by manufacturer	SSPC-10 Near White Blast Clean
Finish Coat	AWWA C210. Provide Devoe Bar Rust 233H or approved equal.

1. Provide dry film thickness in accordance with product manufacturer recommendations. Do not exceed maximum DFT as recommended by manufacturer.
2. Factory Testing: In accordance with AWWA C210.

2.3 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND AND IN VAULTS (EXPOSED)

- A. Provide approved epoxy/polyurethane coating system as designated below. Provide material from same manufacturer.

Surface Preparation as recommended by manufacturer	SSPC SP 10 Near White Blast Clean
Intermediate Coat	Chemical Resistant Epoxy, or approved equal, AWWA C210

Finish Coat	Polyurethane, or approved equal Blue Fed Std. No. 15102 color as approved by Engineer

- B. Total Allowable Dry Film Thickness (DFT) for System: as recommended by manufacturer.
- C. Factory and field testing: in accordance with AWWAC210.
- D. Clean bare pipe free from mud, mill lacquer, oil, grease, or other contaminant. Inspect and clean surfaces according to SSPC-SP-1 to remove oil, grease, and loosely adhering deposits prior to blast cleaning. Remove visible oil and grease spots by solvent wiping. Use only approved safety solvents which do not leave residue. Use preheating to remove oil, grease, mill scale, water, and ice provided pipe is preheated in uniform manner to avoid distortion.
- E. Remove surface imperfections such as slivers, scabs, burrs, weld spatter, and gouges. Grind weld bead for proper coating application as recommended by coating manufacturer. Presence of metallic defects may be cause for rejection of pipe.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

- A. Conform to applicable provisions of Section 02511 - Water lines, except as modified in this Section.
- B. Comply with the following:
 - 1. Bedding and Backfilling: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
 - 2. For pipes with coating: Do not roll or drag pipe on ground, move pipe in such a manner as not to damage pipe or coating. Carefully inspect pipe for abrasions and repair damaged coating before pipe is installed.
- C. Static Electricity:
 - 1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.
 - 2. Electrically test where required after installation is complete.

3.2 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE GROUND AND IN VAULTS (EXPOSED) AND EPOXY INTERNAL LINING SYSTEM.

- A. Safety: Paints, coatings, and linings specified in this Section are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for personnel involved in painting, coating, and lining operations.
- B. Workmanship:
 - 1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.
 - 2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.
- C. Surface Preparation:
 - 1. Prepare surfaces for painting by using abrasive blasting.
 - 2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.
 - 3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP 1.
 - 4. Metal and Weld Preparation: Remove surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter by grinding to 1/4-inch minimum radius.
 - 5. Abrasive Material:
 - a. Blast only as much steel as can be coated same day of blasting.
 - b. Use sharp, angular, properly graded abrasive capable of producing depth of profile specified herein. Transport abrasive to job site in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.
 - c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-Text Coarse or Extra Coarse Press-O-Film Tape, or approved equal. Furnish tapes to Engineer.

- d. Do not blast if metal surface may become wet before priming commences, or when metal surface is less than 5 degrees F above dew point.
 - 6. Evaluate degree of cleanliness for surface preparation with use of SSPC Pictorial Surface Preparation Standards for Painting Steel Surfaces, SSPC-Vis 1.
 - 7. Remove dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air. Test cleanliness by placing ¾-inch by 4 inch piece of clear Scotch type tape on blasted surface, then removing and placing tape on 3x5 white index card. Reclean areas exhibiting dust or residue.
- D. Coating and Lining Application:
- 1. Environmental Conditions: Do not apply coatings or linings when metal temperature is less than 50 degrees F; when ambient temperature is less than 5 degrees F above dew point; when expected weather conditions are such that ambient temperature will drop below 40 degrees F within 6 hours after application; or when relative humidity is above 85 percent. Measure relative humidity and dew point by use of sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychrometric Tables. Provide dehumidifiers for field-applied coatings and linings to maintain proper humidity levels.
 - 2. Application Procedures:
 - a. Apply in accordance with manufacturer's recommendations and requirements of this Section. Provide finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive over spray, or delaminations.
 - b. Thin materials only with manufacturers recommended thinners. Thin only amount required to adjust viscosity for temperature variations, proper atomization and flow-out. Mix material components using mechanical mixers.
 - c. Discard catalyzed materials remaining at end of day.
 - 3. Thoroughly dry pipe before primer is applied. Apply primer immediately after cleaning surface. Apply succeeding coats before contamination of undersurface occurs.
 - 4. Cure a minimum of 24 hours at 77 degrees F before successive coats are applied. During curing process, provide force air ventilation in volume

sufficient to maintain solvent vapor levels below published threshold limit value. Apply successive coats within recoat threshold time as recommended by coating or lining manufacturer on printed technical data sheets or through written communications. Brush blast joints of pipe which have been shop primed and are to receive intermediate and finish coats in field prior to application of additional coats. After interior coatings are applied, provide forced air ventilation in sufficient volume and for sufficient length of time to ensure proper curing before filling pipe with water.

E. Testing of Coatings and Linings:

1. Inspect pipe for holidays and damage to coating:
 - a. If test indicates no holidays and coating is damaged, remove damaged layers of coating and repair in accordance with coating manufacturer's recommendations.
2. Perform holiday test in accordance with NACE Standard Recommended Practice, RPO 188-90, Discontinuity (Holiday) Testing of Protective Coatings.
3. Begin testing of completed coating after coating has sufficiently cured, usually one to 5 days. Consult coating manufacturer for specific curing schedule.
4. Perform adhesion test on pipe in accordance with ASTM D 4541.
5. For coating thickness of 20 mils or less, test with wet sponge low-voltage holiday detector. For coating thickness in excess of 20 mils, test with high-voltage holiday detector. Perform electrical holiday test with 60-cycle current audio detector. Select test voltage as suggested in table below.

MINIMUM VOLTAGES FOR HIGH VOLTAGE SPARK
TESTING

Total Dry Film Thickness (mils)	Suggested Inspection (V)
20 to 40	3,000
41 to 55	4,000
56 to 80	6,000

3.3 JOINTS AND JOINTING

A. Welded Joints:

1. Conform to requirements of Section 02511 - Water Lines.
2. Field weld to be full penetration butt welded joints for steel pipe and encasement sleeves for entire circumference.
3. Authority will employ an independent certified testing laboratory to perform weld acceptance tests on welded joints. Testing Laboratory will test by X-ray methods for butt welds, for 100 percent of joint welds. Engineer has final decision as to suitability of welds tested.

B. Flanged Joints: Conform to requirements of Section 02511 - Water Lines.

3.4 COATINGS AND LININGS INSPECTION RESPONSIBILITIES

- A. Contractor is responsible for quality control of coatings and linings applications and testing and inspection stipulated in this Section. Engineer is responsible for quality assurance and reserves the right to inspect or acquire services of an independent third-party inspector who is fully knowledgeable and qualified to inspect surface preparation and application of high- performance coatings at all phases of coatings and linings work, field- or shop-applied. Contractor is responsible for proper application and performance of coatings and linings whether or not Engineer provides such inspection.

END OF SECTION

Section 02505

HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. High density polyethylene (HDPE) pipe for gravity sanitary sewers and drains, including fittings.
- B. High density polyethylene (HDPE) pipe for sanitary sewer force mains, including fittings.
- C. High density polyethylene (HDPE) pipe for gravity storm sewers and drains, including fittings.
- D. High density polyethylene (HDPE) pipe for storm sewers culverts.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for HDPE pipe under this Section. Include cost in unit prices for work, as specified in following sections:
 - a. Section 02531 - Gravity Sanitary Sewers.
 - b. Section 02631 - Storm Sewers.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 618 - Standard Practice for Conditioning Plastics for Testing.
- B. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
- C. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- D. ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.
- E. ASTM D 2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
- F. ASTM D 2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- G. ASTM D 3035 - Standard Specification for Polyethylene (PE) Plastic Pipe(DR-PR) Based on Controlled Outside Diameter.
- H. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- I. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- J. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- K. ASTM F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
- L. ASTM F 894 - Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.
- M. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
- N. ASTM F 2487 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene and Polypropylene Pipelines 1, 2.

- O. ASTM F 2510 – Standard Specification for Resilient Connectors between Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
- P. AWWA C 906 – Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, pipe length, laying dimensions, fabrication, fittings, flanges, gasket material, and special details.
- C. Submit detailed calculations for pipe design per AASHTO LRFD Bridge Design Specifications.
- D. Submit details of pipe joints and jointing procedure for HDPE pipe.

1.5 QUALITY CONTROL

- A. Provide manufacturer's certificate of conformance to Specifications.
- B. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.
- C. Engineer reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.
 - 1. Manufacturer's Notification: Should Engineer wish to witness manufacture of specific pipes, manufacturer shall provide Engineer with minimum three weeks notice of when and where production of those specific pipes will take place.
 - 2. Failure to Inspect. Approval of products or tests is not implied by Engineer decision not to inspect manufacturing, testing, or finished pipes.
- D. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult Contractor during jointing and installation of pipe.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

PART 2 P R O D U C T S

2.1 GENERAL

- A. Provide products manufactured by companies listed on the City of Houston's Approved Products List.
- B. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.
- C. Furnish profile-wall gravity sanitary sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with elastomeric gasket in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.
- D. Furnish solid wall pipe for sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings.
- E. Furnish corrugated profile-wall polyethylene (CPP) pipe for gravity storm sewer and storm sewer culvert pipe. Joints shall be installed such that connection of pipe sections will form a continuous pipeline free from irregularities in flow line. Suitable joints are:
1. Integral Bell and Spigot. Bell shall overlap minimum of two corrugations of spigot end when fully engaged.
 2. Exterior Bell and Spigot. Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.
- F. Jointing:
1. Gaskets:

- a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.
- b. HDPE Pipes are Not allowed to be installed in potentially contaminated areas, unless approved by the Engineer.

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer

2. Lubricant. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

2.2 MATERIALS FOR SANITARY SEWER

- A. Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting requirements of cell classification 345434D or E, in accordance with ASTM D 3350, are also suitable for making pipe products under these specifications. Inner wall of pipe shall be of light color for television inspection purposes.
- B. Other Pipe Materials: Materials other than those specified in Paragraph 2.2A, Pipe and Fittings, may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

2.3 MATERIALS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

- A. Pipe and Fittings: High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in ASTM D 3350. Manufacturing shall meet requirements of ASTM F 2306.

2.4 TEST METHODS FOR SANITARY SEWER

- A. Conditioning. Conditioning of samples prior to and during tests is subject to approval by the Engineer. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.
 - B. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.5A, in suitable press until internal diameter has been reduced to 40 percent of original inside diameter of pipe. Rate of loading shall be uniform and at 2 inches per minute. Test specimens, when examined under normal light and with unaided eye, shall show no

evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles.
 - C. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace shear load transfer bars and supports with 6-inch-wide support blocks that can be either flat or contoured to conform to pipe's outer contour.
 - D. Purpose of Tests. Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.
- 2.5 TEST METHODS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS
- A. All testing and material requirements shall be in accordance with ASTM F 2306.
 - B. MANDREL TESTING: use a mandrel to test flexible pipe for deflection. Refer to Section 02533 – Acceptance Testing for Sanitary Sewers for a mandrel and test requirements.
- 2.6 MARKING
- A. Mark each standard and random length of pipe in compliance with these Specifications with following information:
 - 1. Pipe size.
 - 2. Pipe class.
 - 3. Production code.
 - 4. Material designation.

PART 3 E X E C U T I O N

3.1 INSTALLATION

- A. Conform to requirements of following Sections:
 - 1. Section 02550 - Sliplining Sanitary Sewers.
 - 2. Section 02531 - Gravity Sanitary Sewers.
 - 3. Section 02532 - Sanitary Sewer Force Mains.
 - 4. Section 02533 - Acceptance Testing for Sanitary Sewers.
 - 5. Section 02571 - Pipe Bursting/Crushing Sanitary Sewers.
 - 6. Section 02631 - Storm Sewers
- B. Install pipe in accordance with the manufacturers recommended installation procedures and ASTM D 2774 for pressure pipe and ASTM D 2321 for gravity flow pipe.
- C. HDPE pipe is not approved in applications requiring augering of pipe.
- D. Bedding and backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
- E. Use only workmen trained in the installation of HDPE Pipe.
- F. Do not store pipe uncovered direct in direct sunlight. Allow pipe temperature to approach ground temperature before each individual pipe section is terminally connected.
- G. Joints: Join sections of HDPE pipe into continuous lengths above ground by thermal butt fusion method in accordance with AWWA C906 and pipe manufacturer's recommendations for specified service. Comply with pipe manufacturer's recommendations for fusion joints and minimum requirements for fusion joint cool down time. Socket fusion and extrusion welding or hot gas welding will not be accepted.
- H. Cutting pipe: Comply with pipe manufacturer's recommendations.

END OF SECTION

Section 02506

POLYVINYL CHLORIDE PIPE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Polyvinyl chloride pressure pipe for water distribution, in nominal diameters 4 inches through 20 inches.
- B. Polyvinyl chloride sewer pipe for gravity sewers in nominal diameters 4 inches through 60 inches.
- C. Polyvinyl chloride pressure pipe for gravity sewers and force mains in nominal diameters 4 inches through 20 inches.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for PVC pipe under this Section. Include cost in unit price for work included as specified in the following sections:
 - a. Section 02511 - Water Lines
 - b. Section 02531 - Gravity Sanitary Sewers
 - c. Section 02631 - Storm Sewers
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ANSI A 21.16 (AWWA C 116) - Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.
- B. ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

- C. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- D. ASTM D 2122 – Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
- E. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- F. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- G. ASTM 2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
- H. ASTM D 2444 - Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
- I. ASTM D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- J. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- K. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- L. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- M. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- N. ASTM F 679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- O. ASTM F 794 - Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- P. ASTM F 949 - Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings.
- Q. AWWA C 110 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 Inches through 48 Inches for Water.
- R. AWWA C 111 - American National Standard for Rubber-Gasket Joints for Ductile-

Iron Pressure Pipe and Fittings.

- S. AWWA C 900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 60 Inches (100mm Through 1500mm).
- T. AWWA C 909 - Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 Inches (100mm) and Larger.
- U. AWWA M23 – PVC Pipe – Design and Installation
- V. PPI TR3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
- W. UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings showing design of new pipe and fittings and indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.
- C. Contractor to review and submit PVC pipe manufacturers recommended installation procedures.
- D. Calculations and limits of thrust restraint shall be based on AWWA M23, latest edition.

1.5 QUALITY CONTROL

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C 900, AWWA C 909 and AWWA C 905 for pressure pipe applications, or appropriate ASTM standard specified for gravity sewer pipe.
- B. Submit manufacturer's certification that PVC pressure pipe for water lines and force mains has been hydrostatically tested at factory in accordance with AWWA C 900, AWWA C 909 and AWWA C 905, and this Section.
- C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from other source is not acceptable. Furnish copies of test reports to Engineer for review. Cost of testing paid by Contractor.

PART 2 P R O D U C T S

2.1 MATERIAL

- A. Use PVC compounds in manufacture of pipe that contain no ingredient in amount that has been demonstrated to migrate into water in quantities considered to be toxic.
- B. Furnish PVC pressure pipe manufactured from Class 12454 virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for rating of 4000 psi for water at 73.4 F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.
- C. PVC Restrained Pipe: Must be listed on City of Houston's current Approved Products List. See <https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction-standards#agency-links-1486>
 - 1. Pipe Material:
 - a. DR 18: For restrained joints where shown on Drawings.
 - b. DR 14: For alternate to offset pipe sections shown on Drawings. Do not use PVC for offset sections with depth of cover greater than 20 feet or less than 4 feet. Do not use PVC in potentially petroleum contaminated areas.
 - c. DR14: For pipe installed beneath, and parallel to, Harris County pavement.
- D. Water Service.
 - 1. Provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.
 - 2. Bear National Sanitation Foundation Seal of Approval (NSF-PW).
- E. Gaskets:
 - 1. Gasket materials shall meet requirements of ASTM F 477. Use elastomeric factory- installed gaskets to make joints flexible and watertight.
 - 2. Flat Face Mating Flange: Full faces 1/8-inch-thick ethylene propylene (EPR)

rubber.

3. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EDR) rubber, with filler gasket between OD of raised face and flange OD to protect flange from bolting moment.
- F. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.
- G. Do not use PVC in potentially or known contaminated areas.
- H. Do not use PVC in areas exposed to direct sunlight.

2.2 WATER SERVICE PIPE

- A. Pipe 4 inch through 12 inch: AWWA C 900, AWWA C 909, Class 150, DR 18; AWWA C 900, Class 200, DR 14 as alternate to offset pipe sections; nominal 20-foot lengths; cast-iron equivalent outside diameters.
- B. Pipe 14 inch through 20 inch: AWWA C 905; DR 18; nominal 20-foot lengths; cast-iron equivalent outside diameter.
- C. Provide Polyvinyl Chloride Pipe from approved manufacturers listed on the City of Houston's Approved Products List.
- D. Make curves and bends by offsetting (i.e., deflecting joints). Do not exceed maximum offset recommended by pipe manufacturer or the Engineer, whichever is less.
- E. Hydrostatic Test: AWWA C 900, AWWA C 905, AWWA C 909, ANSI A 21.10 (AWWA C 110); at point of manufacture; submit manufacturer's written certification.

2.3 GRAVITY SEWER PIPE

- A. PVC gravity sanitary sewer pipe shall be in accordance with provisions in following table:

WALL CONSTRUCTION	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	D3034	SDR 26 / PS 115	6" to 10"
	D3034	SDR 35 / PS 46	12" & 15"
	F679	SDR 35 / PS 46	18" to 60"
	AWWA C900	DR 18 / N/A	4" to 60"
	AWWA C909	DR 18 / N/A	4" and Larger

Note: Refer to City of Houston's current Approved Products List for approved pipe manufacturers.

- B. PVC storm sewer pipe shall be in accordance with provisions in following table:

WALL CONSTRUCTION	MANUFACTURER	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe	D3034	SDR 26 / PS 115	6" to 10"
		D3034	SDR 35 / PS 46	12" & 15"
	CertainTeed	F679	SDR 35 / PS 46	18" to 27"
	Diamond Uponor	AWWA C900	DR 18 / N/A	4" to 60"
	ETI North	AWWA C909	DR 18 / N/A	4" and Larger
	American			
Truss (Gasketed)	Contech	D2680	N/A /200 psi	8" to 15"
Profile	Contech A-2000	F949 F949	N/A / 46 psi	12" to 36"
	Contech A-2026	F794 F794	N/A / 115 psi	8" to 10"
	ETI, Ultra-Rib ETI,		N/A / 46 psi	8" to 30"
	Ultra-Corr		N/A / 46 psi	24" to 36"

- C. When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F 679, except provide wall thickness as required for SDR 26 and pipe stiffness of 115 psi.

- D. For sewers up to 12-inch diameter crossing over water lines, or crossing under water lines with less than 2-foot separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.
- E. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477, or ASTM D 3139 and ASTM F 477. Gaskets shall be factory-assembled and securely bonded or otherwise held in place to prevent displacement. Manufacturer shall test sample from each batch conforming to requirements ASTM D 2444.
- F. Fittings: Provide PVC gravity sewer sanitary bends, tees, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.
 - 1. Fittings for straight through and transition connections to conform to requirements of Section 02534 - Sanitary Sewer Service Stubs or Reconnections.
- G. Conditioning. Conditioning of samples prior to and during tests is subject to approval by the Engineer. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified. This is a brief summary of the test method, and the full current edition of the standard must be followed.
- H. Pipe Stiffness. Determine pipe stiffness at 5 percent deflection in accordance with Test Method D 2412. Minimum pipe stiffness shall be 46 psi. For diameters 4 inches through 18 inches, test three specimens, each a minimum of 6 inches (152 mm) in length. For diameters 21 inch through 36 inch, test three specimens, each a minimum of 12 inch (305 mm) in length. This is a brief summary of the test method, and the full current edition of the standard must be followed.
- I. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraphs 2.30A or 2.30B as applicable, in suitable press until internal diameter has been reduced to 60 percent of original inside diameter of pipe. Rate of loading shall be uniform. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles. Perform the flattening test in conjunction with pipe stiffness test. This is a brief summary of the test method, and the full current edition of the standard must be followed.
- J. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except that joint shall remain watertight at minimum deflection of 5 percent. Manufacturer will be required to provide independent third party certification for joint testing each

diameter of storm sewer pipe. This is a brief summary of the test method, and the full current edition of the standard must be followed

- K. Purpose of Tests. Flattening and pipe stiffness tests are intended to be routine quality control tests. Joint tightness test is intended to qualify pipe to specified level of performance.

2.4 SANITARY SEWER FORCE MAIN PIPE

- A. Provide approved PVC pressure pipe conforming to requirements for water service pipe.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use approved joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.
- C. Fittings: Provide approved ductile iron fittings as per Section 02501 - Ductile Iron Pipe and Fittings, Paragraph 2.4, except furnish fittings with one of following approved internal linings:
 - 1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to interior surface of fitting
 - 2. Nominal 40 mils (35 mils minimum) polyurethane
 - 3. Nominal 40 mils (35 mils minimum) ceramic epoxy
 - 4. Nominal 40 mils (35 mils minimum) fusion bonded epoxy
- D. Exterior Protection: Provide polyethylene wrapping of ductile-iron fittings as required by Section 02528 - Polyethylene Wrap.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.2E.

2.5 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

- A. Bends and Fittings: ANSI A 21.10 or ANSI A 21.53, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating. Approved restrained joints, 250 200 psi, may be provided for up to 12 inches in diameter (water or sanitary).
- B. Provide approved restrained joint fittings: Integral restrained joint fittings and pipe do not require secondary restraint.

PART 3 EXECUTION

3.1 PROTECTION

- A. Store PVC pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with manufacturer's recommendations. Prevent damage by crushing or piercing.
- B.

3.2 INSTALLATION

- A. Conform to requirements of Section 02511 - Water Lines and Section 02531 - Gravity Sanitary Sewers, as applicable.
- B. Install PVC pipe in accordance with Section 02317 - Excavation and Backfill for Utilities, ASTM D 2321 for Sewer Pipe, and manufacturer's recommendations.
- C. Install PVC water service pipe to clear utility lines with minimum 6-inch separation, unless otherwise shown on Drawings.
- D. Avoid imposing strains that will overstress or buckle pipe when lowering pipe into trench.
- E. Hand shovel pipe bedding under pipe haunches and along sides of pipe barrel and compact to eliminate voids and ensure side support. Ensure barrel is fully supported along entire length of pipe, prior to backfilling.
- F. For PVC pipe installed by trenchless methods, provide integral restrained joints and pull pipe through hole or casing. For PVC pipe pushed through hole or casing, provide approved bell insertion protection system.
- G. Allow PVC pipe to cool to ground temperature before backfilling when assembled out of trench to prevent pullout due to thermal contraction.
- H. Pipe Assembly Procedures
 - 1. Do not remove gasket from pipe.
 - 2. Lay pipe by inserting spigot end into bell flush with the insertion line or as recommended by pipe manufacturer.
 - 3. Do not assemble joint by swinging or stabbing.
 - 4. Do not assemble joint using machinery or equipment such as backhoe bucket.

5. At no time shall spigot go past insertion line or homing mark. Continuously observe and check each homing mark for proper length, and install pipe with home mark visible.

3.3 PVC RESTRAINED MECHANISM

A. For low-profile coupling with spline-type joints:

1. Do not apply lubricant to spline or pipe or coupling spline grooves. Do not use excessive force while inserting the spline through coupling.
2. Insert spline until it is fully seated around circumference of pipe.

B. Field Cutting of Pipe Ends:

1. Perform by workers certified by manufacturer.
2. Use a PVC pipe cutter and provide square ends.
3. Follow manufacturer's recommendation to disassemble restrained joint after it has been locked in place.
4. For low-profile coupling with spline-type joints, use manufacturer approved power routing and grooving tool to field fabricate required pipe groove.

END OF SECTION

Section 02507

PRESTRESSED CONCRETE CYLINDER PIPE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Prestressed concrete cylinder pipe (PCCP) and fittings for buried water lines sizes 20 inches and larger.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. No separate payment will be made for PCCP under this Section. Include cost in price for water lines.
 - 2. Maintain on site minimum of two 3-degree and two 5-degree grade angle adapters. Adapters are considered fittings under “extra unit items”. When used during construction, adapters will be paid for at the extra unit item price for the corresponding pipe size.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AASHTO - Standard Specifications for Highway Bridges.
- B. AREA - Manual of Railway Engineering, Volume II, Chapter 15.
- C. ASTM A 648 - Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Pipe.
- D. ASTM A1032 – Standard Test Method for Hydrogen Embrittlement Resistance for Steel Wire Hard Drawn Used for Prestressing Concrete Pipe
- E. ASTM C 33 - Standard Specification for Concrete Aggregates.
- F. ASTM C 35 - Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.

- G. ASTM C 150 - Standard Specification for Portland Cement.
 - H. ASTM C 497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
 - I. ASTM C 1107 (CRD C-621) - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - J. ASTM D 512 - Standard Test Methods for Chloride Ion In Water.
 - K. ASTM D 1293 - Standard Test Methods for pH of Water.
 - L. ASTM E 165 - Standard Test Methods for Dye Penetration.
 - M. ASTM E 340 - Standard Test Methods for Macroetching Metals and Alloys.
 - N. ASTM E 709 - Standard Test Methods for Magnetic Particle Testing.
 - O. ASTM E 1032 - Standard Test Methods for Radiographic Examination of Weldments.
 - P. ANSI/AWS A3.0 - Standard Welding Terms and Definitions.
 - Q. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
 - R. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.
 - S. AWWA C 301 - Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids.
 - T. AWWA C 304 - Standard for Design of Prestressed Concrete Cylinder Pipe.
 - U. AWWA M 9 –Concrete Pressure Pipe.
 - V. NSF 61 - Drinking Water System Components - Health Effects.
 - W. SSPC SP 7 - Surface Preparation Specification No. 7 - Brush Off Blast Cleaning.
- 1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 - Submittal Procedures.
 - B. Submit shop drawings and certification signed and sealed by Professional Engineer registered in State of Texas showing following:
 - 1. Manufacturer's pipe design and thrust restraint calculations in accordance

with AWWA M9, latest edition.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Engineer. Provide final approved lay schedule in Adobe portable document format (*.PDF).
 3. Include hot tapping procedure.
 4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this section.
- C. Within 30 calendar days following Notice to Proceed and before initiation of manufacture of prestressing wire, submit following:
1. Name and location of prestressing wire manufacturer.
 2. General description of quality control procedures used by wire manufacturer. Include physical and chemical property tests utilized, testing frequency and test records; and description of methods employed to assure compliance with AWWA C301 regarding wire surface temperature, type of thermometer, location of temperature measurement, frequency of temperature tests and test records.
 3. Approximate dates when wire will be manufactured for use in pipe.
 4. Hydrogen embrittlement sensitivity test report for wire.
- D. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit standard repair procedures that describe in detail shop and field work to be performed.
- E. Submit following within 45 days after manufacturing of pipe and fittings:
1. Prestressing wire records.
 - a. ASTM A 648 for wire.
 - b. Steel reports as required in AWWA C301, Section 5.2.5.
 - c. Records of testing accomplished to measure wire surface temperature as required in ASTM A648.

- d. Results of other tests of steel reinforcement required in AWWA C301, Section 4.4.7, 4.4.8, and 4.4.9.
 - e. Wire tension records required in AWWA C301, Section 4.6.7.1. Indicate heat and coil of prestressing wire used.
 - 2. Test results.
 - a. Hydrostatic testing, acid etching, dye penetration, magnetic particle and x-ray weld test reports as required.
 - b. Compressive strength (28 day) test results for each type of coating, lining and core mix design.
 - 3. Pipe manufacturer's certification that PCCP:
 - a. Cylinder assembly has been hydrostatically tested at factory for two (2) minutes minimum in accordance with Section 2.1 J and AWWA C301.
 - b. Mortar coatings and linings were applied or allowed to cure at temperature above 32 degrees F.
- F. Submit following for non-shrink grout for special applications:
 - 1. Manufacturer's technical literature including specifications for mixing, placing, and curing grout.
 - 2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C 1107, Non-shrink Grout and requirements of this specification.
 - 3. Certification product is suitable for use in contact with potable water.
- G. Submit proof of certification for welders. Indicate certified procedures and position each welder is qualified to perform. Provide documentation of the most recent weld qualification test date and continuity of use in each process for which the welder or welding operator is required.
- H. Submit certification showing calibration within last 12 months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by the Engineer.

1.5 QUALITY CONTROL

- A. Manufacturer to have permanent quality control department and laboratory facility capable of performing inspection and testing required. Inspection procedures and manufacturing process are subject to inspection by Engineer. Perform manufacturer tests and inspections required by AWWA C 301 as modified by these Specifications. Repair defects when as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, other nonconforming conditions.

1. Cylinder and Joint Ring Assembly:

- a. Review mill certifications for conformance to requirements of Specifications.
- b. Perform physical testing of each heat of steel for conformance to applicable ASTM standards.
- c. Inspect physical dimensions and overall condition of joint rings and cylinder/joint ring assembly to verify compliance with requirements of AWWA C 301.
- d. Test cylinder/joint ring weld for tensile strength. Test one specimen for each 500 cylinder/joint ring assemblies in addition to those tests required by AWWA C 301.
- e. Reject dented steel cylinders.

2. Prestressing Wire:

- a. Inspect wire spacing during wire placement on core.
- b. Test wire splices for each production run or a minimum of once a week, whichever is less, for conformance with minimum strength criteria.

3. Pipe Cores and Coating:

- a. Review mill certificates for each load of cement for conformance to ASTM C 150.
- b. Perform sieve analysis weekly for each source of coarse and fine aggregate for conformance to ASTM C 33.
- c. Inspect kiln recorder charts daily to confirm proper curing environment.

- d. Prior to prestressing, inspect each core for voids, chips, cracks, deleterious surfaces and foreign matter.
 - e. Check mortar batch proportions, moisture content and slurry application rate. Check coating thickness over wire on each pipe.
 - f. Check physical integrity of cured mortar coating.
 - g. Reject pipe with cracks in mortar coating exceeding 0.01 inches wide.
- 4. Protective Coatings: Check daily application rate and resulting dry film thickness.
- B. Gaskets: Randomly test rubber cord for diameter, tensile strength, elongation, compression set, hardness, and specific gravity after oven aging on one out of 100 gaskets.
- C. Weld Testing:
 - 1. Perform macroetching tests for complete-penetration production welds on normal production weld tests. Complete joint penetration welds are defined in ANSI/AWS A3.0. Verify complete joint penetration by means of macroetch of joint weld cross section. Macroetch technique in accordance with ASTM E 340.
 - 2. Perform ultrasonic or x-ray testing of manual butt welds for fittings and special pipes. Perform dye penetration testing of manual lap welds for fittings and special pipes and for joint ring weld onto cylinder.
 - 3. Perform minimum of one set of weld test specimens in accordance with ANSI/AWS A3.0 on each size, grade and wall thickness at minimum of every 3,000 feet of pipe manufactured. Perform no less than one test per project by each welding machine and each operator.
- D. Cast four standard test cylinders each day for each 50 cubic yards of core concrete or mortar coating or portion thereof for each mix placed in day. Perform compressive strength test at 28 days. No cylinder test result shall be less than 80 percent of specified strength.
- E. Make available copy of Physical and Chemical testing reports for steel cylinders and provide reports at request of Engineer.
- F. Check physical dimensions of pipe and fittings: Physical dimensions to include pipe lengths, pipe I.D., pipe O.D. and bend angles.

PART 2 P R O D U C T S

2.1 PRESTRESSED CONCRETE CYLINDER PIPE

- A. Furnish all concrete pressure pipe by same manufacturer.
- B. Provide prestressed concrete cylinder pipe in conformance with AWWA C 301, AWWA C 304 and AWWA M 9 except as modified in this Section. Use of pipe from inventory is permitted only if specifications and certifications are met. Provide testing records for pipe.
- C. Do not use prestressed concrete cylinder pipe in aerial crossings, exposed or other unburied areas.
- D. Pipe Manufacturer:
 - 1. Must have minimum of 5 years of manufacturer's pipe installations that have been in successful and continuous service.
 - 2. Must maintain on site or in plant minimum of four 22.5-degree bends per 10,000 linear feet of water line. Additionally, for 102" pipe and larger, four bevel adaptors must be maintained on site or in the plant. Any combination of bends may be substituted at manufacturer's option (i.e. two 11.25-degree bends are equivalent to one 22.5-degree bend and will be counted as one fitting). Must be capable of delivering bends or bevel adaptors to job site within 12 hours of notification. These fittings are in addition to fittings called out on Drawing and must be available at all times.
- E. Pipe Design Conditions:
 - 1. Working pressure: 150 psi.
 - 2. Hydrostatic field test pressure: 150 psi.
 - 3. Maximum pressure due to surge: 225 psi.
 - 4. Minimum pressure due to surge: -5 psi.
 - 5. Unit weight of soil: 120 pcf minimum, unless otherwise specified.
 - 6. Minimum trench width: O.D. of pipe + four (4) feet.
 - 7. Pipe and Fittings: Designed to withstand most critical simultaneous application of external loads including construction loads and internal pressures.

8. Design: Based on minimum of AASHTO HS-20 loading, AREA Cooper E-80 loads when under railroads, and depths of bury as indicated. Design pipe with Marston's earth loads for transition width trench for all heights of cover.
 - a. Calculate moments and thrusts in wall based on height of earth load, live load, water weight, and pipe weight.
 - b. For earth load heights up to 16 feet, use bedding sand as bedding material and use 90-degree Olander coefficients for earth load, live load, and water weight contained in pipe along with 15-degree Olander coefficients for pipe weight.
 - c. For earth load heights 16 feet and greater, use cement stabilized sand as bedding material below springline of pipe, and use 150-degree Olander coefficients for earth load, live load, and water weight contained in pipe along with a 15-degree Olander coefficient for pipe weight.
9. Groundwater Level: Assume below pipe for pipe design. Assume equal to natural ground surface for other conditions.
10. Design pipe for transmitting potable water, unless otherwise shown on Drawings.
11. Manufacture pipe for adverse environmental conditions in accordance with Section 7.5.5 of AWWA C304.
12. Design pipe for buried conditions and kept empty for up to 365 days.
13. Tunnel and Augered Sections: Provide constant outside diameter from bell to spigot end for pipe. Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and stress anticipated during handling and installation.

F. Coatings and Linings:

1. Provide Portland cement; ASTM C 150, Type I or II. Provide one type of cement for entire project.
2. Water Absorption Test: ASTM C 497, Method A; perform on samples of cured mortar coating taken from each working shift. Cure mortar coating samples in same manner as pipe.

- a. Test Value: Average minimum of 3 samples taken from same working shift, no greater than 9 percent for average value, 11 percent for individual value.
 - b. Test Frequency: Perform tests each working shift until conformance to absorption requirements has been established by 10 consecutive passing test results, at which time testing may be performed weekly. Resume testing for each working shift when absorption test results fail until conformance to absorption requirements is reestablished by 10 consecutive passing test results.
 3. Apply one coat of primer to exposed steel parts of steel bell and spigot rings. Prior to coating, blast clean in accordance with SSPC-SP7 (Brush Off Blast Cleaning). Apply primer in accordance with manufacturer's recommendations.
 4. Coat and line access inlets, service outlets, test inlets and air release/vacuum relief riser pipe with same coating and lining of water line in accordance with AWWA C 301, Section 4, unless otherwise indicated on Drawings.
 5. Do not exceed two hours between application of first and last course when cement mortar is applied in more than one course; otherwise, do not defer placing of coating of any portion of pipe length. Verify cement mortar coating thickness on each size of pipe by nondestructive method before removing pipe from coating machine.
 6. Remove and replace disbonded lining or coating. Reject pipe requiring patches larger than 100 square inches or 12 inches in greatest dimension. Allow no more than one patch on either lining or coating of pipe. Provide WELD-CRETE Probond Epoxy Bonding Agent ET-150, parts A and B; Sikadur 32 Hi-Mod, or approved equal bonding agent for pipe patching.
- G. Fittings and Specials:
1. Design fittings to same internal and external loads as straight pipe.
 2. Manufacture in accordance with Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
 3. Provide fabricated bends or fittings with minimum radius of 2-1/2 times pipe diameter.
 4. Design test plugs to withstand forces generated by hydrostatic test and test pressure from either side. Do not exceed 50 percent of minimum yield for design stresses due to hydrostatic pressure. Assume opposite side of plug does not contain water.

5. Provide no specials less than 4 feet in length unless indicated on Drawings or approved by Engineer.
6. Butt Straps for Closure Piece: Provide at locations indicated on Drawings or authorized by Engineer. Minimum 12-inch-wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Permit no angular deflection or joint offset at butt-strap joints.
7. Provide minimum 6-inch welded outlet for inspecting each closure section, unless access manway is within 40 feet of closure section.
8. Provide Denso petroleum based tape or approved equal for exposed portions of nuts and bolts.

H. Joints:

1. AWWA C 301 rubber-gasketed or welded bell-and-spigot type except where flanged joints are required for valves and fittings as shown on Drawings. Refer to Section 02511 - Water Lines for details on joints and jointing.
2. Rubber-Gasketed Joints: Single weld bell and spigot ring onto steel cylinder. In thrust areas, double weld bell-and-spigot onto steel cylinder. Bond as shown on Drawings to provide electrical continuity along entire pipeline.
3. Restrained Joints: Restrain joints by welding or harnessing joints.
 - a. Design Pressure: 1.5 times working pressure.
 - b. Harnessing Joints: AWWA M 9, clamp or snap ring type, except where prohibited. Limit maximum size of snap ring joints to 48-inch diameter pipe.
 - c. Groundwater Level: Assumed to be equal to natural ground surface.
 - d. Provide restrained joint pipe with adequate cylinder thickness to transmit full thrust generated by internal pressure across joints.
 - 1) Calculate distance of restrained joints based on resistance along each leg of bend with thrust based on bend angle.
 - 2) Calculate cylinder thickness not to be less than that defined in following table:

Inside Diameter (inches)	Cylinder Thickness
Greater than 120	0.25 inch
102 to 120	4 gauge
90 to 96	6 gauge
72 to 84	8 gauge
48 to 66	10 gauge
Less than 48	12 gauge

- 3) Allow cylinder thickness to reduce linearly from maximum calculated thickness or from minimum cylinder thickness (as determined in Paragraph 2.1 H.3.d.1, whichever controls, to minimum thickness required by design over required length (as determined in Paragraph 2.1 H.3.d.1) of restrained joints.
4. Use only fully circumferentially welded joints in areas considered potentially petroleum contaminated, within tunnels and under foreign pipelines. Perform welding in accordance with Section 02511 – Water Lines.
5. Pipe Flanges: AWWA C 207 for standard steel flanges of pressure class corresponding to pipe class.
- I. Pipe Lengths: Provide pipe sections in standard lengths with minimum length of 16 feet and maximum length of 25 feet, and as indicated on approved shop drawings or approved by Engineer. Gasketed joints are allowed on standard lengths of pipe. Non-standard pipe lengths must be approved by Engineer and joints must be welded as specified herein to achieve equal to or greater than standard pipe length before gasketed joints can be used. Internally and externally mark pipe section with durable marking to show location and pipe pressure.
- J. Hydrostatic Test of Cylinder: AWWA C 301, Section 4.6.4.3, at point of manufacture. Hold test for minimum 2 minutes for thorough inspection of cylinder. Repair or reject cylinders revealing leaks or cracks.
- K. Transport fittings 42 inches in diameter and larger with end caps and stulls. Remove end caps just prior to installation. Remove stulls after completion of backfill operation.
- L. Provide radius of curve as indicated on Drawings unless approved by Engineer. Make curves and bends by deflecting joints, by use of beveled joints, or by

combination of two methods, unless otherwise indicated on Drawings. Do not exceed deflection or joint offset angle recommended by pipe manufacturer. Provide beveled pipe sections of standard length used in curved alignment, except when shorter sections are required to limit radius of curvature. In such case, provide sections throughout curve of substantially equal length.

M. When manufacturing straight pipe sections, manual welding is allowed for following:

1. Tack welding of coils and plates during continuous pipe making process.
2. Rewelding and repairing structural defects in plate and automatic machine welds.
3. Attaching new coil of steel to previous coil.

N. Prior to arrival on project site, identify pipe sections within limits of thrust restraint with permanent, brightly colored, and highly visible markings on outer pipe coating as approved by Engineer.

2.2 PRESTRESSING WIRE

A. General:

1. Conform to requirement of ASTM A 648, AWWA C 301 and this specification.
2. Furnish test results from independent manufacturer (i.e., manufacturer with no legal or financial ties to pipe manufacturer). Tests must have been performed within 12 months prior to submittal or when supplier changes.
3. Test foreign manufactured wire by local independent laboratory.
4. Prestressing wire surface temperature: not more than 360 degrees at any point in drawing process. Audit surface temperature of wire throughout length of wire drawing process daily for each working shift producing ASTM A 648 wire.
5. Do not use wire with visible pitting or rust that cannot be wiped off.
6. Do not use wire that fails, for no observable mechanical reason other than tension force, during circumferential wrap. Do not splice, but reject this section of wire.

B. Perform mechanical tests per AWWA C301 - Steel Reinforcement except as modified below:

1. Retest coil for which failed torsion test sample has radial, spiral (that is, longitudinal) split visible to unaided eye or evidenced by abrupt offset in wire surface detectable with fingernail.
 2. Test sample, for mechanical requirements, from 1 of each 10 consecutively produced coils or fraction thereof in each lot. Pipe manufacturer to establish procedures so samples are randomly selected from entire length of wire coils.
- C. Perform hydrogen embrittlement sensitivity testing on samples of prestressing wire in accordance with ASTM A648 and A1032. Test one set of pre-qualified samples for each anticipated wire manufacturing source anticipated by pipe manufacturer for project. Perform tension, wrapping, and torsion on wire samples. Perform pre-qualification testing prior to pipe manufacturing and for each source of supply for wire. Do not use wire failing to conform to test requirements of specification. Acceptance criteria are according to ASTM A648, S1, and AWWA C301, 4.4.8.1. Utilize only wire that meets both of following:
1. Passed aforementioned test.
 2. Manufactured from same source and manufacturing procedures.

2.3 GROUT FOR JOINTS AND SPECIAL APPLICATION

A. Joint Grout:

1. Cement Grout Mixture: One part cement to two parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream.
2. Water: Potable water with total dissolved solids less than 1000 mg/l; ASTM D 512 chloride ions less than 100 mg/l for slurry and mortar cure; ASTM D 1293 pH greater than 6.5. Use potable water with 250 ppm limit on chlorides and sulfates.
3. Portland Cement: ASTM C 150, Type I or II. Provide one type of cement for entire project.
4. Sand:
 - a. Interior joints: ASTM C 35 fine graded plaster sand.
 - b. Exterior joints: ASTM C 33 natural sand with 100 percent passing No. 16 sieve.
5. Mix cement grout to specific gravity of 19 lb/gallon or greater as measured by

grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of Engineer. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.

- B. Provide approved Nonshrink Grout for Special Applications, Patches and Repairs.
1. Conform to requirements of ASTM C 1107, Nonshrink Grout.
 2. Pre-blended factory-packaged material manufactured under rigid quality control.
 3. Contain non-metallic natural aggregate, be non-staining and non-corrosive.
 4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.
 5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.
 6. Non-bleeding and non-segregating at fluid consistency.
 7. Contain no chlorides or additives which may contribute to corrosion of prestressed concrete cylinder pipe.
 8. Free of gas-producing, gas-releasing agents.
 9. Resist attack by oil or water.
 10. Mix, place, and cure in accordance with manufacturer's recommendations. Upon 72 hours notice, provide services of qualified representative of nonshrink grout manufacturer to aid in use of product under job conditions.
 11. Mix non-shrink grout to specific gravity of 17.7 lb/gallon or greater as measured by grout/slurry balance. Use grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and at request of Engineer. Add additional cement grout or water to bring mix to proper moisture content or specific gravity. Discard grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.
 12. Compressive strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.
- C. Finished surface of lining and interior joint to be comparable to surface rubbed with

No. 16 carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

- D. Joint Wrapper: Minimum width of 9 inches for 33-inch diameter and smaller; minimum width of 12 inches for diameters greater than 33 inch hemmed at edge to allow threading with minimum 5/8-inch-wide steel strap. Provide minimum 6-inch-wide wire Ethafoam strip sized, positioned, and sewn circumferential in center of wrapper.

2.4 CATHODIC PROTECTION

- A. Connect each joint of pipe with bonding straps or approved devices to maintain continuity of current. Provide bonding straps free of foreign material.
- B. Electrically isolate water line from other connections. Use insulating type joints or nonmetallic pipe unless otherwise indicated on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Conform to requirements of Section 02511 - Water Lines. Do not install pipe without approved lay schedule.
- B. Manufacturer will make available services of representative, throughout project duration when deemed necessary by Project Manager, to advise aspects of installation including but not limited to handling, storing, cleaning and inspecting, coatings and linings repairs, and general construction methods affecting pipe.
- C. Bedding and Backfilling:
 - 1. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
 - 2. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.
 - 3. Do not move trench support system (trench safety system) once bedding material is compacted.
 - 4. Excavate outside specified trench section for bell holes, and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell

holes as required or directed by Engineer. Subsequent backfilling thereof will not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of Engineer.

5. Remove blocking after placing sufficient backfill to hold pipe in position.
 6. Use cement-stabilized sand in areas of trench excavation 16 feet and greater, as bedding material up to springline of pipe.
- D. Follow nonshrink grout manufacturer's specifications for nonshrink grouting.
- E. Install each pipe section in sequence identified on lay schedule. Deviations from lay schedule sequence shall be approved by Engineer and denoted on final lay schedule.
- F. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by Engineer, in-place survey data for pipe laid each day and submit copy of data to Engineer at end of that day. Survey data to include unique pipe number, deflection or joint offset angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom, and at springline (each side).
- G. Static Electricity:
1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.
 2. Electrically test where required after installation of pipeline is complete.

3.2 CLOSURES AND APPROVED PIPE MODIFICATIONS

- A. No modifications of standard pipe for closures will be permitted in field. No field cutting of pipe or exposure of prestressed wire is permitted without written approval from Engineer.
- B. Pipe manufacturer's representative and Engineer to entirely witness closures and approved pipe modification efforts.
- C. Provide minimum lap of 4 inches between member being joined and edge of butt strap. Weld on both interior and exterior, unless otherwise approved by Engineer.
- D. Provide full circumferential welds on joints required to be welded. Employ independent certified testing laboratory, approved by Engineer, to perform weld tests on field welds. Include cost of testing in contract unit price for water line. Use magnetic particle test method for lap welds or X-ray methods for butt welds, for 100

percent of joint welds. Maintain records of tests. When defective weld is revealed, repair defective weld, and retest. Use wire and flux from same manufacturer throughout entire project.

- E. Fill wrapper in field and allow excess grout water to seep out. Refill wrapper as necessary. When joint mortar level has stabilized and begun to mechanically stiffen, lap Ethafoam wrapper over top of joint, and secure in place.
- F. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

3.3 VISIBLE CRACKS

- A. No visible cracks longer than 6 inches, measured to be within 15 degrees of line parallel to pipe longitudinal axis, are permitted except:
 - 1. In surface laitance of centrifugally cast concrete,
 - 2. In sections of pipe with steel reinforcing collars or wrappers, or
 - 3. Within 12 inches of pipe ends.
- B. Repair interior lining cracks that exceed 1/16-inch (0.0625 inches) wide.
- C. Reject pipe with exterior coating cracks that exceed 0.01 inches wide.
- D. Immediately remove pipe from site when pipe has cracks exceeding limitations and cracks are not repairable.

3.4 FIELD REPAIR PROCEDURES FOR COATING/LINING

- A. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with non-shrink grout conforming to section 2.3 B. Use only manual or small (low pressure) air chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with non-shrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off non-shrink grout flush with surrounding surface after patch has stiffened sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.
- B. Pipe with defective coating areas greater than 6 inches in diameter cannot be used. Immediately remove pipe from project.
- C. Reject pipe when steel cylinder is dented while making field repair. Immediately remove pipe from project.

END OF SECTION

Section 02511

WATER LINES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Installation of water lines.
- B. Specifications identify requirements for both small diameter water lines and large diameter water lines. When specifications for large diameter water lines differ from those for small diameter water lines, large diameter specifications will govern for large diameter pipe.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for water lines installed by open-cut, or trenchless construction or aerial crossing, with or without restrained joints, with or without welded joints, with or without thrust blocks, with or without casing, within limits of pipe offset section or within limits of Potentially Petroleum Contaminated Area (PPCA) or within limits of Fault Hazard Zone (FHZ) is on linear foot basis for each size of pipe installed. Separate pay items are used for each type of installation.
 - a. Mains: Measure along axis of pipe and include fittings and valves.
 - b. Branch Pipe: Measure from axis of water line to end of branch.
 - 2. Payment for interconnection is on lump sum basis for each interconnection identified on Drawings. Payment will include flanges required for insulating joints, tapping sleeve and valve if required, piping, connection and other related work necessary for construction as shown on Drawings or specified herein.
 - 3. Payment for removal of existing internal elliptical or dished head plug is on unit price basis for each internal elliptical or dished head plug removed. Payment will include removal of plug, drainage or dewatering of water lines, repair of damaged linings, rechlorination and items incidental to operation.
 - 4. Payment for plug and clamp is on a unit price basis for each size of pipe.
 - 5. Payment for drain line connection with service manhole is on unit price basis

for each drain line shown on drawings. Payment includes valve, access manhole and connection.

6. Payment for cylindrical corrosion barriers is on a unit price basis for each pipe fitting installed with one or more barriers.
7. When directed by Engineer to install extra fittings as required to avoid unforeseen obstacles, payment will be based on the following:
 - a. Each extra fitting requested by Engineer and delivered to jobsite will be paid according to unit price for "Extra Fittings in Place."
 - b. Payment will include and be full compensation for items necessary for installation and operation of water line.
8. No separate payment will be made for bell protection system for PVC pipe. Include cost in related unit price work.
9. Refer to Section 01270 - Measurement and Payment for unit price procedures.
10. No separate payment will be made for installation of water line marker. Include cost in unit price for water lines.

- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- B. ANSI/NSF Standard 61 - Drinking Water System - Health Components.
- C. ASTM A 36 - Standard Specification for Carbon Structural Steel.
- D. ASTM A 536 - Standard Specification for Ductile Iron Castings.
- E. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- F. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.
- G. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

- H. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
- I. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
- J. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.
- K. ASTM E 709 - Standard Guide for Magnetic Particle Examination.
- L. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
- M. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
- N. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Conform to submittal requirements of applicable Section for type of pipe used.
- C. Photographs: Submit photographs conforming to requirements of Section 01321 - Construction Photographs prior to commencement of construction.
- D. Submit videotapes conforming to requirements of Section 01323 - Construction Videotapes, if applicable.
- E. Submit Lone Star notification transmittal number prior to beginning excavation.
- F. Submit, a minimum of 15 days before beginning pipe manufacturing, layout drawing identifying proposed sections for disinfecting, hydrostatic testing and site restoration for entire project for review and approval. Site restoration; not to exceed limits specified; sequence in order of disturbance.
- G. For water lines to be field welded, submit proof of certification of field welders per AWWA C206. Indicate certified procedures and position each welder is qualified to perform. Provide documentation of the most recent weld qualification test date and continuity of use in each process for which the welder or welding operator is required.

PART 2 P R O D U C T S

2.1 PIPE MATERIALS

- A. Install pipe materials which conform to following:
 - 1. Section 02501 - Ductile Iron Pipe and Fittings.
 - 2. Section 02502 - Steel Pipe and Fittings. Water line piping within plant site and aerial crossings to be welded joint steel pipe with flange or approved restraint joint connections, unless otherwise shown on Drawings.
 - 3. Section 02506 - Polyvinyl Chloride Pipe.
 - 4. Section 02507 - Prestressed Concrete Cylinder Pipe.
 - 5. Section 02509 – Fiberglass Reinforced Pipe for Pressure Mains
 - 6. Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
 - 7. Section 02613 - Bar-Wrapped Steel Cylinder Pipe.
- B. Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.
- C. Type of pipe materials used is Contractor's option unless specifically identified on Drawings.
- D. Provide minimum of 3/8 inch inside joint recess between ends of pipe in straight pipe sections.

2.2 WELDED JOINT PROTECTION FITTING FOR SMALL DIAMETER STEEL PIPE

- A. Cylindrical Corrosion Barrier: Provide approved cylindrical corrosion barrier.
- B. O-rings: Conform to National Sanitary Foundation requirements.

2.3 RESTRAINED JOINTS

- A. Ductile-Iron Pipe: See Section 02501 - Ductile Iron Pipe and Fittings.
- B. PVC Pipe: See Section 02506 - Polyvinyl Chloride Pipe. Perform hydrostatic testing in accordance with ASTM F 1674.
- C. Prestressed Concrete Cylinder Pipe, Bar-Wrapped Pipe and Steel Pipe: Welded

joints (see Paragraph 3.6C).

- D. Except for trenchless installation, restrained joints where required on DIP and PVC pipe are allowed with the following requirements as an alternative to the pipe with an integral restrained joint system:

1. Restraint Devices: Manufacture of high-strength ductile iron, ASTM A 536. Working pressure rating twice that of design test pressure.
2. Bolts and Connecting Hardware: High-strength low-alloy material in accordance with ANSI A21.11/AWWA C111.

- E. For ductile iron or PVC pipes in augered holes, provide restrained joints that are integral to both the bell and spigot ends, and do not extend beyond or increase the outside diameter of the bell.

- F. For small diameter water lines crossing under sanitary sewer lines or laterals, provide ductile iron pipe with locking or bolted type restrained joints.

2.4 COUPLINGS AND APPURTENANCES FOR LARGE DIAMETER WATERLINE

- A. Flexible (Dresser-type) Couplings:

1. Install where shown on Drawings or where allowed by Engineer for Contractor's convenience. Use galvanized flexible couplings when installed on galvanized pipe which is cement lined, or when underground. Provide gaskets manufactured from neoprene or Buna-N.
2. For steel pipe, provide approved sleeve-type flexible couplings. Thickness of middle ring equal to or greater than thickness of pipe wall.
3. Provide approved flanged adapter couplings for steel pipe.
4. Use ASTM A193 Grade B7 high strength steel bolts and ASTM A194 heavy hex nuts where flexible couplings are installed underground. Provide cadmium plated hardware. Mark bolts and nuts according to ASTM. Coat entire coupling with Denso or approved equal petrolatum-based tape.

- B. Flap Valves: Provide approved flap valves on discharge of manhole drain line as shown on Drawings.

1. Body and Flap: ASTM A 126-B cast iron.
2. Seats: ASTM B 21-CA482 or ASTM B 301-CA145 bronze.
3. Resilient Seat

- 4. Hinge Arms: ASTM B 584-CA865 high tensile bronze.
- 5. Hinge Pins: ASTM B 98-CA655 silicon bronze.
- C. Flexible Expansion Joints: Install Flexible Expansion Joints at locations indicated on drawings, within limits of Fault Hazard Zone (FHZ), in accordance with the manufacturer's recommendations.

2.5 CASING FOR OPEN CUT

- A. For water line by open cut in casing, casing used shall conform to Specification Section 02425 (LD) – Tunnel Excavation and Primary Liner for Water Mains.

PART 3 EXECUTION

3.1 PREPARATION

- A. Conform to applicable installation specifications for types of pipe used.
- B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.
- C. Lay pipe to lines and grades shown on Drawings.
- D. Confirm 9 feet minimum separation from gravity sanitary sewers and manholes or separation of 4 feet minimum from force mains as specified in this Section in all directions unless special design is provided on Drawings.
- E. Where above clearances cannot be attained, and special design has not been provided on Drawings, obtain direction from Engineer before proceeding with construction.
- F. Inform Engineer if unmetered sprinkler or fire line connections exist which are not shown on Drawings. Make transfer only after approval by Engineer.
- G. For projects involving multiple subdivisions or locations, limit water line installation to maximum of two project site locations. Maximizing two pipe installation crews shall be permitted, unless otherwise approved by Engineer.
- H. Contractor shall not operate existing Authority valves. Notify Engineer a minimum 30 days in advance when operation of existing valves are required for wet connections and chlorination. Contractor is responsible for handling necessary installations and removal of blow-offs, chlorination and testing taps, and risers.

- I. If asbestos-cement (A.C.) pipe is encountered, follow safety practices outlined in OSHA 29 CFR 1926.1101 – Asbestos. Refer to Section 02221 – Removing Existing Pavements, Structures, Wood, and Demolition Debris for removing and disposing of A.C. Pipe.
- J. For pipe diameters 36 inches and greater, clearly mark each section of pipe and fitting with unique designation on inside of pipe along with pressure class. Locate unique identifying mark minimum of 5 feet away from either end of each section of pipe. Provide one unique identifying mark in middle of each fitting. Place markings at consistent locations. Use permanent black paint and minimum letter height of 4 inches to mark designations.
- K. Contractor is responsible for assuring chosen manufacturer fulfills requirements for extra fittings and, therefore, is responsible for costs due to downtime if requirements are not met.
- L. Do not remove plugs or clamps during months of peak water demands; June, July and August, unless otherwise approved by Engineer.

3.2 HANDLING, CLEANING AND INSPECTION

A. Handling:

- 1. Place pipe along project site where storm water or other water will not enter or pass through pipe.
- 2. Load, transport, unload, and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.
- 3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.
- 4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon, or similar material. Slings shall be wide enough so as to damage coating. Spreader bar with two slings required for large diameter water lines over 36-feet.
- 5. Use precautions to prevent injury to pipe, protective linings and coatings.
 - a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.

- b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.
 - c. Do not lift pipe using hooks at each end of pipe.
 - d. Do not place debris, tools, clothing, or other materials on pipe.
 - e. Place pipe on timbers, tires or soil berms at the jobsite. Do not place pipe directly on ground. Do not let pipe ends touch ground.
- 6. Repair damage to pipe or protective lining and coating before installation.
- 7. For cement mortar lined and coated steel pipe and PCCP, permit no visible cracks wider than 1/16-inch anywhere.
- 8. Repair pipe with visible cracks that exceed project specifications. If cracks cannot be repaired to specification remove from project site.
- B. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation, and keep interior clean until Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove debris. Broom sweep all mortar lined pipe to remove dust.
- C. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.3 EARTHWORK

- A. Conform to applicable provisions of Section 02317 - Excavation and Backfilling for Utilities.

3.4 PIPE CUTTING

- A. Cut pipe 12 inches and smaller with standard wheel pipe cutters. Cut pipe larger than 12 inches in manner approved by Engineer. Cutting of Bar Wrapped or PCCP will not be allowed. Make cuts smooth and at right angles to axis of pipe. Bevel plain end with heavy file or grinder to remove sharp edges.

3.5 PIPING INSTALLATION

A. General Requirements:

1. When trench width below top of pipe becomes 4 feet wider than specified, install higher class of pipe or improved bedding, as determined by Engineer. No additional payment will be made for higher class of pipe or improved bedding.
2. Lay pipe in subgrade free of water.
3. Properly form bedding to fully support barrel without wedging or blocking up bell.
4. Open Cut Construction: Cover or backfill laid pipe if pipe laying operations are interrupted and during non-working hours. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints. If adjustment of pipe is required after it has been laid, remove and re-lay as new pipe. Lay not more than 50 feet of pipe in trench ahead of backfilling operations without approval in writing from Engineer. Maintain access for property owners across easement when access to remainder of property is needed.
5. Prevent damage to coating when placing backfill. Use backfill material free of large rocks or stones, or other material which could damage coatings.

B. Install pipe continuously and uninterrupted. Obtain approval of Engineer prior to skipping any portion of Work.

1. Before assembling couplings, lightly coat pipe ends and outside of gaskets with approved pipe lubricant and relieve tension in gaskets.
2. Prior to proceeding with critical tie-ins, submit sequence of work based on findings from "critical location" effort.
3. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record "as- built" horizontal alignment and vertical grade at maximum of every 100 feet on record drawings. Provide X, Y, and Z coordinates in electronic format every 100 feet and at all bends and appurtanances.

C. Protection of Pipeline: Securely place stoppers or bulkheads in openings and in end of line when construction is stopped temporarily and at end of each day's work.

D. Perform Critical Location as shown on Drawings. Refer to Section 02317 -

Excavation and Backfill for Utilities for additional requirements at critical locations.

- E. Assessment of deflection may be measured by Engineer at location along pipe. Arithmetical averages of deflection or similar average measurements will not be deemed as meeting intent of standard. Refer to pipe material specifications for maximum allowable pipe deflection.
- F. Perform following additional procedures when working on plant sites.
 - 1. Seven days prior to each plant shutdown or connection, schedule coordination meeting with Engineer and Authority staff personnel. At this meeting, present proposed sequencing of Work and verification of readiness to complete Work as required and within time permitted. Do not proceed with Work until Engineer agrees key personnel, equipment and materials are on hand to complete Work.
 - 2. Prior to fully excavating around existing piping, excavate as minimal as possible to confirm type and condition of existing joints. Verify size, type, and condition of pipe prior to ordering materials or fully mobilizing for Work.
 - 3. Do not proceed with connections to existing piping and identified critical stages of work unless approved by Engineer and Authority's Utility Maintenance Operator is present to observe.
 - 4. Coordinate with the Authority's Water System Operator to obtain reduction in operating pressures prior to performing connections to existing piping.
 - 5. Make connections to existing piping only when two valves are closed off between connection and source of water pressure and a blow-off valve is open to relieve pressure between the two closed valves. Do not make connection relying solely on one valve, unless otherwise approved by Engineer.
 - 6. Perform critical stages of Work identified on Drawings at night or during low water demand months as specified in Section 01110 - Summary of Work.
 - 7. Excavation equipment used on plant sites to have smooth bucket; no teeth or side cutters.
 - 8. Submit to Engineer Lone Star Notification transmittal number prior to beginning excavation.
 - 9. Before each "dig" with mechanical excavator, probe ground to determine potential obstructions. Repeat procedure until existing pipe is located or

excavation reaches desired elevation. Perform excavations within one foot to existing piping by hand methods.

10. Provide adequate notice to Engineer and pipe manufacturer's representative when connecting or modifying existing prestressed or pretension concrete cylinder pipe.
 11. Provide field surveyed (horizontal and vertical elevations) "as-builts" of new construction and existing underground utilities encountered. Submit in accordance with Section 01330 - Submittal Procedures.
 12. Prior to performing plant work to be done on weekend, provide list of sites and contact person with phone numbers to Engineer by noon on Thursday of week. Contact person must be accessible during weekend, have Houston Metro Area phone number, and be authorized to make emergency decisions.
 13. No night work or plant shutdown will be scheduled to begin two working days before or after designated Authority Holidays.
- G. Maintain water services at all times to all customers, fire hydrants, and inter-connections. Provide temporary connections and temporary bypass as necessary for construction. No additional payment will be made for temporary connections unless specified on the drawings.
- H. For tie-ins to existing water lines, provide necessary material on hand to facilitate connection prior to shutting down existing water line. Provide Authority a minimum of two weeks notice prior to shutting down existing water line.
- I. For exposed portions of piping within manholes or vaults, including outlets, flanges, blind flanges, nuts, bolts, valves, actuators, and piping, apply finish coat after installation is complete. Provide cycloaliphatic amine epoxy in light blue color. Follow manufacturer procedures for preparing surface and applying coating. Submit coating manufacturer's product data sheet and color sample to Engineer for review.

3.6 JOINTS AND JOINTING

- A. Rubber Gasketed Bell-and-Spigot Joints for Concrete Cylinder Pipe, Bar Wrapped Pipe, PVC Pipe, Steel Pipe, and Ductile Iron Pipe (DIP):
1. After rubber gasket is placed in spigot groove of pipe, equalize rubber gasket cross section by inserting tool or bar recommended by manufacturer under rubber gasket and moving it around periphery of pipe spigot.
 2. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined.

3. Fit pipe units together in manner to avoid twisting or otherwise displacing or damaging rubber gasket. After pipe sections are joined, check each gasket to ensure that no displacement of gasket has occurred. If displacement has occurred, remove pipe section and remake joint as for new pipe. Remove old gasket, and replace before remaking joint.
 4. Provide means to prevent full engagement of spigot into bell in accordance with Paragraph 2.1 D. For PVC pipe, means may consist of an approved bell insertion protection system.
- B. Flanged Joints where required on Concrete Cylinder Pipe, Bar Wrapped Pipe, Ductile Iron Pipe, or Steel Pipe:
1. AWWA C 207. Prior to installation of bolts, accurately center and align flanged joints to prevent over stressing of flanges, pipe and equipment. Align bolt holes to straddle vertical, horizontal or north-south center line. Do not exceed 3/64 inch per foot inclination of flange face from true alignment.
 2. Use ring type or full-face gaskets for flanged joints. Provide gasket material in accordance with AWWA C207. Cut gaskets at factory to proper dimensions. In PPCA areas, provide gasket material in accordance with Section 02105 – Chemical Sampling and Analysis.
 3. Provide ASTM A193 Grade B7 high strength steel stud bolts with ASTM A194 heavy hex nuts. Use cadmium-plated steel hardware underground. Mark bolts and nuts according to ASTM. Tighten bolts per AWWA C604. Provide bolting procedure from manufacturer. Provide Denso petrolatum-based tape or approved equal for all exposed portions of nuts, bolts and pipe hardware.
 4. Isolation Joints:
 - a. Provide full-face Type “E” gasket. For 30-inch diameter and greater, provide Pyrox G-10 material and EPDM sealing element. For 24-inch diameter and smaller, provide Phenolic material and EPDM sealing element. Provide full-length bolt isolating sleeves and washers. Bolt holes shall be oversized to accommodate bolt isolating sleeves. Provide matching steel washers on both sides of each insulating washer on every bolt. Furnish kits in accordance with Specification Section 15640 – Joint Bonding and Electrical Isolation.
- C. Welded Joints (Concrete Cylinder Pipe, Bar Wrapped Pipe, Steel Pipe):
1. Prior to starting work, provide certification of qualification for welders employed on project for type of work procedures and positions involved.

2. Steel Pipe Joints: AWWA C 206. See Section 02502 – Steel Pipe and Fittings or Section 02518 – Steel Pipe and Fittings for Large Diameter Water Lines. Refer to Contract Drawings for joint details. For interior welded joints, complete backfilling before welding. For exterior field-welded joints, provide adequate working room under and beside pipe. Use exterior welds for 30-inch and smaller.
3. Concrete Pipe Joints: See Section 02507 – Prestressed Concrete Cylinder Pipe or Section 02613 – Bar-Wrapped Steel Cylinder Pipe. Refer to Contract Drawings for joint details. Align piping and equipment so that no part is offset more than 1/8 inch. Set fittings and joints square and true, and preserve alignment during welding operation. For butt-welded joints, align abutting ends to minimize offset between surfaces. For pipe of same nominal wall thickness, do not exceed 1/16 inch offset. Use line-up clamps for this purpose; however, take care to avoid damage to linings and coatings.
4. Welding Rods: Compatible with metal to be welded to obtain strongest bond, E-70XX.
5. Deposit metal in successive layers to provide 1 to 3 passes or beads as required to complete the structural weld or control heat in the weld after backfilling the joint.
6. Deposit no more than 1/4 inch of metal on each pass. Thoroughly clean each individual pass with wire brush or hammer to remove dirt, slag or flux.
7. Do not weld under weather conditions that would impair strength of weld, such as wet surface, rain or snow, dust or high winds, unless work is properly protected.
8. Make tack weld of same material and by same procedure as completed weld. Otherwise, remove tack welds during welding operation.
9. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, or valves.
10. Welded Joints for Large Diameter Water Lines:
 - a. Use exterior welds for 30-inch and smaller.
 - b. Employ an independent certified testing laboratory, approved by Engineer, to perform weld acceptance tests on welded joints. Include cost of such testing and associated work to accommodate testing in contract unit price bid for water line. Furnish copies of test reports to Engineer for review. Engineer has final decision as to suitability of

welds tested.

- 1) Weld acceptance criteria:
 - a) Conduct in accordance with ASTM E709 - Standard Guide for Magnetic Particle Examination. Use X-ray methods for butt welds, for 100 percent of joint welds.
 - b) Examine welded surfaces for the following defects:
 - i. Cracking.
 - ii. Lack of fusion/penetration.
 - iii. Slag which exceeds one-third (t) where (t) equals material thickness.
 - iv. Porosity/Relevant rounded indications greater than 3/16 inch; rounded indication is one of circular or elliptical shape with length equal to or less than three times its width.
 - v. Relevant linear indications in which length of linear indication exceeds three times its width.
 - vi. Four or more relevant 1/16-inch rounded indications in line separated by 1/16 inch or less edge to edge.
11. After pipe is joined and prior to start of welding procedure, make spigot and bell essentially concentric by jacking, shimming or tacking to obtain clearance tolerance around periphery of joint except for deflected joints.
12. Furnish each welder employed steel stencil for marking welds, so work of each welder can be identified. Mark pipe with assigned stencil adjacent to weld. When welder leaves job, stencil must be voided and not duplicated. Welder making defective welds must discontinue work and leave project site. Welder may return to project site only after recertification.
13. Scaffolding: Do not drag scaffolding or other items along interior of pipe.
14. Provide cylindrical corrosion barriers for polyurethane or epoxy-lined or coated steel pipe 24-inch diameter and smaller, unless minimum wall thickness is 0.5 inch or greater.
 - a. In addition to welding requirements contained here in Paragraph 3.6,

conform to protection fitting manufacturer's installation recommendations.

- b. Provide services of technical representative of manufacturer available on site at beginning of pipe laying operations. Representative to train welders and advise regarding installation and general construction methods. Welders must have 12 months prior experience. All steel pipe is to have cutback 3/4 inch to no greater than 1 inch of internal diameter coating from weld bevel.
- c. Furnish steel fittings with cylindrical corrosion barriers with shop welded extensions to end of fittings. Extension length to measure no less than diameter of pipe. Shop apply lining in accordance with AWWA C 210 or AWWA C 222.
- d. All steel pipe receiving field adjustments are to be cold cut using standard practices and equipment. No cutting using torch is to be allowed.

D. Harnessed Joints (Concrete Cylinder Pipe, Bar Wrapped Pipe or Steel Pipe):

- 1. Use of snap-ring type restrained joints on pipe is limited to 20-inch through 48-inch diameters.
- 2. Position snap-ring joint bolt on top (12 o'clock portion). Provide minimum 1/2-inch joint recess. Use joint "diapers" minimum of 12 inches wide.
- 3. For field adjustments with deflections or joint offsets beyond manufacturer's recommendations:
 - a. Field trim spigot.
 - b. Do not engage ring.
- 4. Harnessed joints are not permitted in areas defined on Drawings as potentially petroleum contaminated material, in tunnels, or at bend greater than 5 degrees.
- 5. Install harness type joints including snap rings at straight sections of pipe.
- 6. Vitalic Advanced Grooved System (AGS) or approved equal for steel pipe installed per manufacturer recommendations. Thickness of grooved section of steel pipe shall exceed minimum required wall thickness.

E. Restrained Joints:

1. For existing water lines and water lines less than 16 inches in diameter, restrain pipe joints with concrete thrust blocks unless otherwise shown on Drawings.
2. Thrust restraint lengths shown on Drawings are minimum anticipated lengths. These lengths are based on deflections or joint offsets indicated and on use of steel pipe for large diameter lines and ductile iron pipe for small diameter lines. Adjustments in deflections or joint offsets or use of other pipe material may result in reduction or increase of thrust lengths.
3. Pipe manufacturer or representative to perform thrust restraint calculations in accordance with latest revision of applicable standard for pipe material chosen. Submit calculations for all pipe materials sealed by a registered Professional Engineer in State of Texas for review by Engineer. Make adjustments in thrust restraint lengths at no additional cost to Authority.
4. Include buoyancy conditions for soil unit weight when computing thrust restraint calculations.
5. Passive resistance of soil will not be permitted in calculation of thrust restraint.
6. For 16-inch lines and larger, use minimum 16-foot length of pipe in and out of joints made up of beveled pipe where restraint joint lengths are not identified on Drawings. Otherwise, provide restraint joints for a minimum length of 16 feet on each side of beveled joints.
7. Installation.
 - a. Install restrained joints mechanism in accordance with manufacturer's recommendations.
 - b. Examine and clean mechanism; remove dirt, debris and other foreign material.
 - c. Apply gasket and joint NSF 61 FDA food grade approved lubricant.
 - d. Verify gasket is evenly seated.
 - e. Do not over stab pipe into mechanism.
8. Prevent any lateral movement of thrust restraints throughout pressure testing and operation.
9. Place 2500 psi concrete conforming to Section 03315 - Concrete for Utility Construction, for blocking at each change in direction of existing water lines,

to brace pipe against undisturbed trench walls. Finish placement of concrete blocking, made from Type I cement, 4 days prior to hydrostatic testing of pipeline. Test may be made 2 days after completion of blocking if Type II cement is used.

- F. Joint Grout (Concrete Cylinder Pipe, Bar Wrapped Pipe, Mortar Coated and Lined Steel Pipe):
1. Mix cement grout mixture by machine except when less than 1/2 cubic yard is required. When less than 1/2 cubic yard is required, grout may be hand mixed. Mix grout only in quantities for immediate use. Place grout within 20 minutes after mixing. Discard grout that has set. Retempering of grout by any means is not permitted.
 2. Prepare grout in small batches to prevent stiffening before it is used. Do not use grout which has become so stiff that proper placement cannot be assured without rettempering. Use grout for filling grooves of such consistency that it will adhere to ends of pipe.
 3. Surface Preparation: Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces with wire brush or hammer to sound, clean surface. Remove rust and foreign materials from metal surfaces in contact with grout.
 4. Follow established procedures for hot and cold weather concrete placement.
 5. Complete joint grout operations and backfilling of pipe trenches as closely as practical to pipe laying operations. Allow grouted exterior joints to cure at least 2 hours before compacting or placing backfill material.
 6. Grouting Exterior Joint Space: Hold wrapper in place on both sides of joint with minimum 5/8-inch-wide steel straps or bands. Place no additional bedding or backfill material on either side of pipe until after grout band is filled and grout has mechanically stiffened. Pull ends of wrapper together at top of pipe to form access hole. Pour grout down one side of pipe until it rises on other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for 15 minutes to allow excess water to seep through joint band. When necessary, add more grout to fill joint completely. Protect gap at top of joint band from backfill by allowing grout to stiffen or by covering with structurally protective material. Do not remove band from joint. Proceed with placement of additional bedding and backfill material.
 7. Interior Joints for Pipe 24 Inches and Smaller: Circumferentially butter bell with grout prior to insertion of spigot, strike off flush surplus grout inside pipe by pulling filled burlap bag or inflated ball through pipe with rope. After joint is engaged, finish off joint grout smooth and clean. Use swab

- approved by Engineer for 20-inch pipe and smaller.
8. Protect exposed interior surfaces of steel joints by pointing with grout. Remove and replace improperly cured or otherwise defective grout.
 9. Strike off grout on interior joints and make smooth with inside diameter of pipe.
 10. When installed in tunnel or encasement pipe and clearance within casing does not permit outside grout to be placed in normal manner, apply flexible sealer, such as Flex Protex or equal, to outside joint prior to joint engagement. Clean and prime surfaces receiving sealer in accordance with manufacturer's recommendations. Apply sufficient quantities of sealer to assure complete protection of steel in joint area. Fill interior of joint with grout in normal manner after joint closure.
 11. Interior Joints for Water Lines 30 Inches and Larger: Clean joint space, wet joint surfaces, fill with stiff grout and trowel smooth and flush with inside surfaces of pipe using steel trowel so that surface is smooth. Accomplish grouting at end of each work day. Obtain written acceptance from Engineer of inside joints before proceeding with next day's pipe laying operation. During inspection, insure no delamination of joint mortar has occurred by striking joint mortar lining with rubber mallet. Remove and replace delaminated mortar lining.
 12. Work which requires heavy equipment to be over water line must be completed before mortar is applied to interior joints.
- G. Large Diameter Water Main Rubber Gasket Joint Testing: In addition to testing individual joints with feeler gauge approximately 1/2 inch wide and 0.015-inch thick, use other joint testing procedure approved or recommended by pipe manufacturer which will help ensure watertight installation prior to backfilling. Perform tests at no additional cost to Authority.
- H. Make curves and bends by deflecting or offsetting joints or other method as recommended by manufacturer and approved by Engineer. Submit details of other methods of providing curves and bends which exceed manufacturer's recommended deflection or joint offset prior to installation.
1. Deflection of pipe joints shall not exceed maximum deflection recommended by pipe manufacturer, unless otherwise indicated on Drawings.
 2. If deflection exceeds that specified but is less than 5 percent, repair entire deflected pipe section such that maximum deflection allowed is not exceeded.
 3. If deflection is equal to or exceeds 5 percent from that specified, remove

entire portion of deflected pipe section and install new pipe.

4. Replace, repair, or reapply coatings and linings as required.
 5. Assessment of deflection may be measured by Engineer at location along pipe. Arithmetical averages of deflection or similar average measurement methods will not be deemed as meeting intent of standard.
 6. When rubber gasketed pipe is laid on curve, join pipe in straight alignment and then deflect or offset to curved alignment.
- I. Closures Sections and Approved Field Modifications to Steel Pipe, Concrete Cylinder Pipe, Bar Wrapped Pipe, and Fittings:
1. For large diameter water lines, provide minimum overlap of 4 inches on each side for butt-strap closures.
 2. For pipe diameters 36 inches and greater, perform field welds on interior and exterior of pipe.
 3. Apply welded-wire fabric reinforcement to interior and exterior of exposed interior and exterior surfaces greater than 6 inches in diameter. Welded-wire fabric: minimum W1; maximum spacing 2 inches by 4 inches; 3/8 inch from surface of steel plate or middle third of lining or coating thickness for mortar thickness less than 3/4 inch.
 4. Fill exposed interior and exterior surfaces with non-shrink grout.

3.7 CATHODIC PROTECTION APPURTENANCES

- A. Where identified on Drawings, modify pipe for cathodic protection as detailed on Drawings and specified. Unless otherwise noted, provide insulation kits including test stations at connections to existing water system or at locations to isolate one type of cathodic system from another type, between water line, access manhole piping and other major openings in water line, or as shown on Drawings.
- B. Bond joints for pipe installed in tunnel or open cut, except where insulating flanges are provided. Weld strap, wire or clip between bell and spigot of each joint or as shown on Drawings. No additional bonding required where joints are welded for thrust restraint. Repair coatings as specified by appropriate AWWA standard, as recommended by manufacturer, and as approved by Engineer.
- C. Bonding Strap or Clip: Free of foreign material that may increase contact resistance between wire and strap or clip.

3.8 SECURING, SUPPORTING AND ANCHORING

- A. Support piping, as shown on Drawings and as specified in this Section, to maintain line and grade and prevent transfer of stress to adjacent structures.
- B. Where shown on Drawings, anchor pipe fittings and bends installed on water line by welding consecutive joints of pipe together to distance each side of fitting. Restrained length, as shown on Drawings, assumes that installation of pipe and subsequent hydrostatic testing begin upstream and proceed downstream, with respect to normal flow of water in pipe. If installation and testing differs from this assumption, submit for approval revised method of restraining pipe joints upstream and downstream of device used to test against (block valve, blind flange or dished head plug).
- C. Use adequate temporary blocking of fittings when making connections to distribution system and during hydrostatic tests. Use sufficient anchorage and blocking to resist stresses and forces encountered while tapping existing water line.

3.9 POLYETHYLENE WRAP FOR DUCTILE IRON PIPE

- A. Conform to requirements of Section 02528 - Polyethylene Wrap.

3.10 CLEANUP AND RESTORATION

- A. Provide cleanup and restoration crews to work closely behind pipe laying crews and, where necessary, during disinfection and hydrostatic testing, service transfers, abandonment of old water lines, backfill and surface restoration.
- B. Unless otherwise approved by Engineer, comply with the following:
 - 1. Once water line is installed to limits approved in layout submitted, immediately begin preparatory work for hydrostatic testing and disinfection effort.
 - 2. No later than three days after completing hydrostatic and disinfection preparatory work, submit to Engineer appropriate request to proceed with hydrostatic testing and disinfection. Request shall include the proposed limits for hydrostatic testing and disinfection.
 - 3. Within seven days from submission of request, and if approved by Engineer, pipe laying operations may continue beyond approved limits for hydrostatic testing and disinfection.
 - 4. After successful testing and disinfection, immediately transfer services (where required), and begin abandonment of old water lines (where required) and Site Restoration.

- C. Site Restoration: Replacement or reconstruction of Site Improvements (defined in Paragraph D below) located in rights-of-way, easements, public property, and private property, affected or altered by the Work.
- D. Site Improvements: Includes pavement, curbs and gutters, esplanades, sidewalks, driveways, fences, lawns, irrigation systems, landscaping, trees and other improvements in existence at the Project site before commencement of construction operations.
- E. For large diameter water lines, do not install more than 2,000 linear feet of water line, without the previous 2,000 linear feet being restored in accordance with this specification section. Schedule paving crews so repaving work will not lag behind pipe laying work by more than 1,000 linear feet. Failure to comply with this requirement shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions of the Construction Contract.

3.11 CLEANING PIPING SYSTEMS

- A. Remove construction debris or foreign material and thoroughly broom clean and flush piping systems. Provide temporary connections, equipment and labor for cleaning. Authority must inspect water line for cleanliness prior to filling.

3.12 DISINFECTION OF WATER LINES

- A. Conform to requirements of Section 02514 - Disinfection of Water Lines.

3.13 FIELD HYDROSTATIC TESTS

- A. Conform to requirements of Section 02515 - Hydrostatic Testing of Pipelines.

END OF SECTION

Section 02512

WATER TAP AND SERVICE LINE INSTALLATION

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Tapping existing mains and furnishing and installing new service lines for water.
- B. Relocation of existing small water meters.
- C. Specifications identify requirements for both small-diameter (less than or equal to 20 inches) water lines and large-diameter (greater than 20 inches) water lines. When specifications for large-diameter water lines differ from those for small-diameter water lines, paragraphs for large-diameter water lines will govern for large-diameter pipe.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for water taps and copper service lines 3/4 inch through 1 inch is on unit price basis for each installation. Separate measurements will be made for "short side", "long side" and "extra long side" connections as defined in Paragraph 1.4, Definitions.
 - 2. Payment for water taps and service lines 1-1/2 inch through 2 inch is on unit price basis for each installation. Separate measurements will be made for "short side", "long side" and "extra long side" connections as defined in Paragraph 1.4, Definitions.
 - 3. Payment for "short side", "long side" and "extra long side" includes locating water line, tap installation and connection to meter and restoring site.
 - 4. Payment for each small meter includes labor, materials, and equipment to relocate existing small meter.
 - 5. No additional payment will be made for bedding, backfill, compaction, push under pavement, etc.
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for working this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.
- B. AWWA C 900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12in., for Water Distribution.
- C. AWWA C105 – Polyethylene Encasement for Ductile-Iron Pipe Systems.

1.4 DEFINITIONS

- A. Short Side Connection: Service line connecting proposed curb stop, located inside water meter box, to water line on same side of street.
- B. Long Side Connection: Service line connecting proposed curb stop, located inside water meter box, to water line on opposite side of street or from center of streets where supply line is located in street center such as boulevards and streets with esplanades. Distance not to exceed 60 linear feet (at right angles to water line).
- C. Extra Long Side Connection: Service line connecting proposed curb stop, located inside water meter box, to water line on opposite side of street or from center of streets where supply line is located in street center such as boulevards and streets with esplanades. Distance greater than 60 linear feet (at right angles to water line).

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Copper Tubing: In accordance with Section 02503 - Copper Tubing. Polybutylene tubing is not permitted.
- B. Corporation Stops: AWWA C 800 as modified in this Section:
 - 1. Inlet End: AWWA standard thread.
 - 2. Valve Body: Tapered plug type, O-ring seat ball type, or rubber seat ball type.
 - 3. Outlet End: Flared-copper connection for use with Type K, soft copper or compression type fitting.

- C. Provide taps for water line types and sizes in accordance with Table 2512-1 Pipe Tapping Schedule located at end of this Section.
- D. Dual Strap Saddles: Red brass body and straps; ductile-iron; vinyl-coated body and straps; or ductile-iron, vinyl-coated body and stainless-steel straps.
- E. Taps for PVC Water Lines: Use dual-strap or single, wide-band strap saddles which provide full support around circumference of pipe and bearing area of sufficient width along axis of pipe, 2 inches minimum, ensuring that pipe will not be distorted when saddle is tightened. Provide approved stainless-steel tapping saddle with AWWA standard thread.
- F. Taps for Steel Pipe: Not allowed, unless specifically approved by Engineer. Use saddle only when tap is approved on steel pipe.
- G. Curb Stops and Brass Fittings: AWWA C 800 as modified in this Section.
 - 1. Inlet End: Flared copper connection or compression-type fitting
 - 2. Valve Body: Straight-through or angled, meter-stop design equipped with following:
 - a. O-ring seal straight plug type.
 - b. Rubber seat ball type.
 - 3. Outlet End: Female, iron-pipe thread or swivel-nut, meter-spud thread on 3/4-inch and 1-inch stops and 2-hole flange on 1 1/2 and 2-inch sizes.
 - 4. Fittings: Provide approved fittings. Use same size open end wrenches and tapping machines as used with respective Mueller fittings.
 - 5. Factory Testing of Brass Fittings:
 - a. Submerge in water for 10 seconds at 85 psi with stop in both closed and open positions.
 - b. Reject fitting that shows air leakage. Engineer may confirm tests locally. Entire lot from which samples were taken will be rejected when random sampling discloses unsatisfactory fittings.
- H. Angle Stops: In accordance with AWWA C 800; ground-key, stop type with bronze lock- wing head stop cap; inlet and outlet threads conform to application tables of AWWA C 800; and inlets flared connection or compression.
 - 1. Outlet for 3/4-inch and 1-inch size: Meter swivel nut with saddle support.

2. Outlet for 1 1/2-inch through 2-inch size: O-ring sealed meter flange, iron pipe threads.
- I. Fittings: In accordance with AWWA C 800 and following:
1. Castings: Smooth, free from burrs, scales, blisters, sand holes, and defects which would make them unfit for intended use.
 2. Nuts: Smooth cast and has symmetrical hexagonal wrench flats.
 3. Flare-Joint Fittings: Smooth cast. Machine seating surfaces for metal-to-metal seal to proper taper or curve, free from pits or protrusions.
 4. Thread fittings, of all types, shall have N.P.T. or AWWA threads, and protect male threaded ends in shipment by plastic coating, or approved equal.
 5. Compression tube fittings shall have Buna-N beveled gasket.
 6. Stamp of manufacturer's name or trademark and of fitting size on body.

PART 3 EXECUTION

3.1 GENERAL

- A. For service lines and lateral connections larger than those allowed in Pipe Tapping Schedule, branch connections and multiple taps may be used. Space corporation stops minimum of 2 feet apart.
- B. Tapped collars of appropriate sizes: Approved in new construction only provided they are set at right angles to proposed meter location.
- C. Use tapping machine manufactured for pressure tapping purposes for 2-inch and smaller service taps on pressurized water lines.
- D. For new meter or when existing meter is in conflict with proposed pavement improvements, locate water meters one foot inside street right-of-way, or when this is not feasible, one foot on curb side of sidewalk. Contact Engineer when major landscaping or trees conflict with service line and meter box location. No additional payment will be made for work on customer side of meter.
- E. New location and installation of existing small meter shall conform to requirements of this Section.

- F. Successfully perform hydrostatic and disinfection testing prior to installing service taps and lines.

3.2 SERVICE INSTALLATION

- A. Set service taps at right angles to proposed meter location and locate taps in upper pipe segment within 45 degrees of pipe spring line.
- B. Install service lines in accordance with Section 02317 - Excavation and Backfill for Utilities.
- C. Lay service lines with minimum of 30 inches of cover as measured from top of curb or, in absence of curbs, from centerline elevation of crowned streets or roads. Provide minimum of 18 inches of cover below flow line of ditches to service lines.
- D. Service lines across existing street (push-unders): Pull service line through prepared hole under paving. Use only full lengths of tubing. Take care not to damage copper tubing when pulling it through hole. Compression-type union is only permitted when span underneath pavement cannot be accomplished with a full standard length of tubing. Use one compression-type union for each full length of tubing.
- E. Maintain service lines free of dirt and foreign matter.
- F. Install service lines so that top of meter will be 4 to 6 inches below finished grade.
- G. Anticipate existing sanitary sewers to have cement stabilized sand backfill to bottom of pavement. Include cost of such crossings in unit price for services.
- H. When copper line must be installed in cement stabilized sand use an 8 MIL polyethylene encasement tubing in accordance with AWWA C105.

3.3 CURB STOP INSTALLATION

- A. Set curb stops or angle stops at outer end of service line inside of meter box. Secure opening in curb stop to prevent unwanted material from entering. In close quarters, make S-curve in field. Do not flatten tube. In 3/4-inch and 1-inch services, install meter coupling, swivel-nut, or curb stop ahead of meter. Install straight meter coupling on outlet end of meter.

3.4 GALVANIC CORROSION CONTROL

- A. For 1 1/2" and 2" meters utilizing two bolt flanges, install 2.5 ounce sacrificial zinc anode caps meeting ASTM B418-88 requirements on the end of each bolt on both outlet and inlet side of the meter connection.

3.5 SEQUENCE OF OPERATIONS

- A. Open trench for proposed service line in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Install curb stop on meter end of service line.
- C. With curb stop open and prior to connecting service line to meter in slack position, open corporation stop and flush service line thoroughly. Close curb stop, leaving corporation stop in full-open position.
- D. Check service line for apparent leaks. Repair leaks before proceeding.
- E. Schedule inspection with Engineer prior to backfilling. After inspection, backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.
- F. Install meter box centered over meter with top of lid flush with finished grade.
Meter box: Refer to Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

Table 02512-1

PIPE TAPPING SCHEDULE				
WATERLINE TYPE AND DIAMETER	SERVICE SIZE			
	3/4"	1"	1-1/2"	2"
4" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
4" Asbestos Cement	WBSS	WBSS	DSS, WBSS	DSS, WBSS
4" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" Asbestos Cement	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
12" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
12" Asbestos Cement	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
12" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
16" and Up Cast Iron or Ductile Iron	DWBSS	DWBSS	DWBSS	DWBSS
16" and Up Asbestos Cement	DWBSS	DWBSS	DWBSS	DWBSS
16" and Up PVC (AWWA C905)	DWBSS	DWBSS	DWBSS	DWBSS

DSS - DUAL STRAP SADDLES

WBSS - WIDE BAND STRAP SADDLES

DWBSS - DUAL WIDE BAND STRAP SADDLES

END OF SECTION

Section 02513

WET CONNECTIONS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Wet connections for new water lines and service lines to existing water lines.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for wet connections shown on Drawings is on unit price basis for each wet connection. Separate payment will be made for each size of water line.
 - 2. No compensation will be given for extra work or for damages occurring as result of incomplete shutoff.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.
- B. OSHA 29 CFR 1926.1101 - Asbestos.

1.4 DEFINITIONS

- A. Wet connections consist of isolating sections of pipe to be connected with existing valves, draining isolated sections, and completing connections.
- B. Connection of 2-inch or smaller lines, which may be referred to on Drawings as "2-inch standard connections" or "gooseneck connections" will be measured as 2-inch wet connections. This item is not to be used as part of 2-inch service line.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Pipe shall conform to requirements of applicable portions of Sections 02501 through 02528 related to piping materials and to water distribution.

- B. Corporation cocks and saddles shall conform to requirements of Section 02512 - Water Tap and Service Line Installation.
- C. Valves shall conform to requirements of Section 02521 - Gate Valves.
- D. Brass fittings shall conform to requirements of AWWA C 800.

PART 3 EXECUTION

3.1 CONNECTION OPERATIONS

- A. Plan wet connections in manner and at hours with least inconvenience public. Notify Engineer at least 72 hours in advance of making connections.
- B. Do not operate valves on water lines in use by Authority or other entity. Authority operator will handle, at no cost to Contractor, coordination of operations involving opening and closing valves for wet connections on Authority system. Contact operator of other entity to coordinate wet connections as needed to other systems, no separate pay.
- C. Conduct connection operations when Representative is at job site. Connection work shall progress without interruption until complete once existing water lines have been cut or plugs have been removed for making connections.

3.2 2-INCH WET CONNECTIONS

- A. Tap water line. Use corporation cocks, saddles, copper tubing as required for line and grade adjustment, and brass fittings necessary to adapt to existing water line. Use 2-inch valves when indicated on Drawings for 2-inch copper gooseneck connections.

3.3 CONNECTIONS TO ASBESTOS-CEMENT (AC) PIPE

- A. Notify Engineer when AC pipe is encountered.
- B. Refer to Section 02221 – Removing Existing Pavements and Structures for crew training, safety precautions, and AC pipe removal requirements.
- C. Protocol:
 - 1. Mechanically excavate to no more than 6 in. of AC Pipe. Carefully uncover the remainder of pipe by hand or with shovel.
 - 2. Keep pipe adequately wet before and during work.
 - 3. Place 2 layers of 6 mil polyethylene sheeting under the asbestos pipe to prevent soil

contamination.

4. Use hand tools to remove collars. Replace minimum 6 ft. section of pipe. Use of power tools is prohibited.
5. Do not crush AC pipe in place. Remove waste AC pipe.

END OF SECTION

Section 02514

DISINFECTION OF WATER LINES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Disinfection of potable water lines.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices:

1. Payment for disinfection preparation and disinfection of water lines is on a linear foot basis for large diameter water lines being disinfected. Payment will include installation and removal of all temporary plugs, piping, pumps, fittings, valves, blow-offs, air valves and other necessary appurtenances for filling and draining the water line and performing the Work in the specification section.
2. Payment will include procurement, transportation, delivery, staging, use and disposal of required chlorination and de-chlorination chemicals necessary for successful disinfection.
3. Payment for water not provided from the WHCRWA system to be reimbursed on an Actual Cost Basis to cover the fees and expenses related to the purchase of water for disinfection and hydrostatic testing as approved by the Engineer. Allowance will only include purchase of water and not any transportation or temporary piping, fittings, or other necessary appurtenances required.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

1.03 REFERENCES

- A. AWWA C 651 - Standard for Disinfecting Water Mains.
- B. AWWA C 652 – Disinfection of Water Storage Facilities.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.

- B. Submit water line disinfection plan for approval before commencing disinfection work.
- C. Submit manufacturer's details of meter for measuring water delivered to water line and water removed from water line.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.01 CONDUCTING DISINFECTION

- A. Unless otherwise approved by Engineer, promptly disinfect water lines constructed before hydrostatic tests are conducted on water lines and before water lines are connected to Authority's water distribution system.
- B. Water for disinfection of waterline will be furnished by WHCRWA if connection to existing WHCRWA system with water is available. If connection to existing WHCRWA is not available, then Contractor to acquire water and will be reimbursed via an allowance as defined in Specifications.
- C. Contractor will conduct disinfection operations in accordance with applicable standards list in Section 1.03.
- D. Coordinate chlorination operations through all involved parties, Program Engineer, Construction Manager, West Harris County Regional Water Authority Operations, City of Houston, etc.

3.02 PREPARATION

- A. Provide temporary blind flanges, cast-iron sleeves, plugs, necessary service taps, copper service leads, risers and jumpers of sizes, location and materials, and other items needed to facilitate disinfection of new water lines prior to connection to the Authority's water transmission system. Provide and install temporary riser piping and sample taps at necessary intervals and/or ARV and access manway locations as per AWWA standard.
- B. Make temporary connections to City of Houston/local hydrants as necessary to sustain filling of the water main. Contractor to obtain meters and approval for such connections.
- C. Perform a full interior visual inspection of the water line with Engineer before beginning the chemical disinfection process. This will determine if any mechanical cleaning of the pipe interior needs to be performed beforehand.

- D. Use air release valves, access manholes or install temporary blow-off valves as necessary, to be removed promptly upon successful completion of disinfection and testing.
- E. After application of chemical disinfection outlined in Section 3.03, slowly fill each section of pipe with water in manner approved by Engineer. During filling operations, expel air from pipeline.

3.03 DISINFECTION BY CONTRACTOR

- A. The following procedure will be used when disinfection by Contractor is required by Contract Documents:
 - 1. After passing visual inspection of the water line, introduce chlorinating material to water lines in accordance with AWWA C652.
 - 2. During contact period, open and close valves several times in line(s) being disinfected.
 - 3. After contact period, in accordance with the standard, fill system with clean water, and flush if necessary, until residual chlorine is no greater than 1.0 parts per million parts of water. Surface Water Supply Projects do not require flushing of the water line to reduce chlorine residual.
 - 4. Prior to removing water from water line, de-chlorinate water as necessary in accordance with AWWA C651.

3.04 BACTERIOLOGICAL TESTING

- A. After disinfection and flushing of water lines, bacteriological tests will be performed by Authority or testing laboratory in accordance with Section 01454 - Testing Laboratory Services. When test results indicate need for additional disinfection of water lines based upon Texas Department of Health requirements, perform additional disinfection operations.

3.05 COMPLETION

- A. Upon completion of disinfection and testing, remove risers except those approved for use in subsequent hydrostatic testing, and backfill excavation promptly.
- B. Surface Water Supply Project waterlines to have be left with a chlorine residual of 9 to 10 ppm at the completion of hydrostatic and disinfection testing.

END OF SECTION

Section 02515

HYDROSTATIC TESTING OF PIPELINES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Field hydrostatic testing of newly installed water pipelines.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. No payment will be made for hydrostatic testing of pipelines, filling and draining the water line with potable water, or the installation of temporary plugs, piping, pumps, fittings, valves, blow-offs, air valves and other necessary appurtenances for filling and draining the water line under this Section. Include cost in unit price of pipelines being disinfected and tested.
2. Payment for water not provided from the WHCRWA system to be reimbursed on an Actual Cost Basis to cover the fees and expenses related to the purchase of water for disinfection and hydrostatic testing as approved by the Engineer. Allowance will only include purchase of water and not any transportation or temporary piping, fittings, or other necessary appurtenances required.
3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

- A. Disinfect water system pipelines prior to hydrostatic testing or as directed by Engineer.
- B. Water for hydrostatic testing will be furnished by WHCRWA if connection to existing WHCRWA system with water is available. If connection to existing WHCRWA is not

available, then Contractor to acquire water and will be reimbursed via an allowance as defined in Specifications.

- C. Test large diameter pipelines between valves or plugs, in sections as determined by the Contractor, subject to approval by Engineer. Add temporary internal plugs as necessary to facilitate testing sections of the desired length.
- D. Conduct hydrostatic tests in presence of Engineer to record beginning, hourly and ending pressure and added gallons. When testing a section of pipe against a valve, applying hydrostatic pressure to the opposite side of an isolation valve is not allowed, unless otherwise approved by Engineer.

3.2 TEST PROCEDURES

- A. Furnish, install, and operate connections, pump, meter and gages necessary for hydrostatic testing.
- B. Allow pipeline to sit minimum of 24 hours from time it is fully filled until testing begins, to allow pipe wall or lining material to absorb water. Periods of up to 7 days may be required for mortar lining to become saturated.
- C. For large diameter water lines, expel air and apply minimum test pressure of 150 psi. Measurement of hydrostatic pressure shall be performed at the point of lowest practical hydrostatic head for the tested section, and will result in exposure of pipeline lower in elevation to pressures above 150 psi.
- D. Begin test by 9:00 a.m. unless otherwise approved by the Engineer. Maintain test pressure for 8 hours. When large quantity of water is required to maintain pressure during test, discontinue testing until cause of water loss is identified and corrected.
- E. If applicable, keep valves inside pressure reducing stations closed during hydrostatic pressure test.

3.3 ALLOWABLE LEAKAGE FOR WATERLINES

- A. During hydrostatic tests, no leakage will be allowed for sections of water lines consisting of welded joints.
- B. Maximum allowable leakage:
 - 1. Water lines with welded and flanged joints only: zero allowable leakage.
 - 2. No leakage is allowed through any resilient seated valve. Leakage through metal

seated valves shall not exceed manufacturers' maximum rated leakage.

3.4 CORRECTION FOR FAILED TESTS

- A. Upon discovering a leak during the hydrostatic test, identify location of pipe leak. Determine magnitude and extent of impact to surrounding soil. Based on this information, no separate payment will be made to restore areas disturbed by location and repair of a leak.
- B. Repair joints showing visible signs of leakage on surface regardless of total leakage shown on test. Check valves and fittings to ensure that no leakage occurs that could affect or invalidate test. Remove cracked or defective pipes, fittings, and valves discovered during pressure test and replace with new items.
- C. Engineer may require failed lines to be disinfected after repair and prior to retesting. Conduct and pay for subsequent disinfection operations in accordance with requirements of Section 02514 - Disinfection of Water Lines. Contractor is responsible for obtaining water required for additional disinfection and retesting.
- D. Repeat test until satisfactory results are obtained.

3.5 COMPLETION

- A. Upon satisfactory completion of disinfection and hydrostatic testing, remove risers and cap directly at the water line. Do not leave any portion of riser extending from water line. Backfill excavation promptly. Show blow-off locations on as-built record drawings, and note the type of cap used. If blow-off location is underneath pavement, comply with the following:
 - 1. If pavement is restored prior to completion of disinfection and hydrostatic testing, install temporary pavement over blow-off. Comply with Street Cut Ordinance for dimensions of temporary pavement.
 - 2. Backfill excavation with select fill or cement stabilized sand in accordance with Section 02320 – Utility Backfill Materials and Section 02317 – Excavation and Backfill for Utilities.
- B. Surface Water Supply Project waterlines to have be left with a chlorine residual of 9 to 10 ppm at the completion of hydrostatic and disinfection testing.

END OF SECTION

Section 02516

CUT, PLUG AND ABANDONMENT OF WATER LINES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Cut, plug and abandonment of water lines.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for cut, plug, and abandonment of water lines is on a unit price basis for each cut, plug, and abandonment performed. Separate payment will be made for each size of water line.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for proposed plugs and clamps for approval.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Concrete for reaction blocks: Class B conforming to requirements of Section 03315 - Concrete for Utility Construction.
- B. Plugs and clamps: Applicable for type of pipe to be plugged.

END OF SECTION

Section 02517

WATER LINE IN TUNNELS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Handling, transporting, and installing water line in primary liner tunnels, including invert cleanup and blocking and water line in casings that will be backfilled with concrete or grout.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment of water line installed by tunneling is by linear foot along center line of completed water line as designated on Drawings.
2. Payment for installation of water line in tunnel constructed according to Section 02425 - Tunnel Excavation and Primary Liner will be authorized by Engineer in three parts. Pay estimates for partial payments will be made as measured above according to following schedule:
 - a. 60 percent of installation will be authorized when excavation and primary liner installation is complete.
 - b. 95 percent of installation will be authorized when water line installation and grouting is complete.
 - c. 100 percent of installation will be authorized when section successfully hydrostatically tested.
3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCE STANDARDS

- A. ASME B 40.1 - Pressure Gauge and Gauge Attachments.

1.4 SUBMITTALS

- A. Submit work plan including following information in accordance with Section 01330 - Submittals.
 - 1. Method of transporting pipes into tunnel.
 - 2. Method of hoisting and positioning pipe in tunnel.
 - 3. Method of jointing and aligning pipe.
 - 4. Method of supporting and blocking pipe.
 - 5. Tunnel ventilation while setting pipe and completing joints, when applicable
 - 6. Material, equipment and procedures for grout placement and other information required by Section 02431 - Tunnel Grout.
- B. Submit results of tunnel primary liner survey in accordance with Paragraph 3.02, Tunnel Survey.
- C. Submit results of installed water line survey in accordance with Paragraph 3.10, As-built Survey and Installation Tolerances.

1.5 PROCEDURES

- A. Joints: Prepare joints as recommended by pipe manufacturer and in accordance with Section 02511 - Water Lines.
- B. Handling: Handle, store, and transport pipe in accordance with pipe manufacturer's recommendations and to prevent damage to pipe ends, pipe barrel, steel reinforcement, and pipe protective linings.
- C. Grouting: Perform grouting of annular space between water line and tunnel liner to fill voids with grout, without dislocating or damaging pipe.

PART 2 PRODUCTS

2.1 ANNULAR GROUT

- A. Specified in Section 02431 - Tunnel Grout

2.2 CONCRETE

- A. Meeting requirement of Section 03315 - Concrete for Utility Construction, Class B concrete.

2.3 PIPE MATERIAL AND FITTINGS

- A. Manufacture and deliver pipe material and fittings as described in Section 02511 - Water Lines.

2.4 SPACERS

- A. Unless otherwise noted on Drawings, use casing spacers between water line and casing tunnel liner for water lines less than 36 inches in diameter. Refer to Paragraph 3.01 for exception. See Section 02447 - Augering Pipe for Water lines for spacer requirements and installation.

PART 3 EXECUTION

3.1 APPLICATION

- A. Grout in place tunnels for water lines with diameters of 36 inches or greater. When tunnel liner plate is used, grout water line in place regardless of water line diameter.

3.2 TUNNEL SURVEY

- A. Prior to installing water line in tunnel: Perform survey of tunnel in accordance with Paragraph 3.10B. Verify tunnel has been constructed within specified tolerances for line, grade, and roundness and water line to be placed in tunnel can be placed in conformance with tolerances specified. Should misalignment of tunnel preclude proper installation of water line, notify Engineer of proposed correction method. Engineer will make final decision on acceptability of correction.

3.3 PIPE TRANSPORT

- A. Transport pipe in tunnel for final placement so that no damage occurs to pipe ends or pipe barrel and interior lining or exterior coating. Repair pipe damaged during transport or final placement in tunnel in manner acceptable to Engineer prior to joining. Remove damaged pipe from tunnel and replace, when directed by Engineer, at no additional cost to Authority.

3.4 TUNNEL CLEANUP

- A. Remove temporary tunnel utilities, loose material, dirt, and debris prior to pipe placement. Broom clean concrete invert. Control seepage and remove standing water in invert.
- B. Temporary construction tracks or pipe skids may be left in place when they do not interfere with alignment of water line, short circuit cathodic protection system, or interfere with final placement of annular grout.

3.5 INVERT PIPE SUPPORT

- A. Construct invert pipe support of screeded concrete, steel beam, or other method, as approved, to final grade of outside of water line. Secure invert support to primary liner to prevent movement. Cure concrete support minimum of 48 hours prior to setting pipe. Maintain minimum of 4 inches clearance between outside of water line and steel beam or steel member.

3.6 JOINING PIPE IN TUNNELS

- A. Lay pipe in accordance with pipe manufacturer's recommendations, and as specified in this Section. Join pipe segments so as to properly compress gaskets and allow for correct final positioning of pipe for line and grade. Closely align pipe and bring loosely together by means of hydraulic jacks, locomotives, pipe mobiles, or winches. Once pipes have been loosely joined, pull home by means of hydraulic tugger or other similar methods suitably protecting pipe and joints against damage. Impact joining, such as ramming with locomotives or other mechanical equipment, is not permitted.

3.7 SUPPORTING PIPE IN TUNNEL AND BULKHEADS

- A. Develop and submit pipe supporting system that will prevent water line from floating and deforming beyond specified limits. Loads imposed on pipe, primary liner and surrounding soil during grouting shall be determined by Registered Professional Engineer in State of Texas. Show essential details in plan for supporting system. Position water line in tunnel to allow minimum of 4 inches of grout to be placed between water line and tunnel primary liner or casing.
- B. Wooden support blocks are not allowed.
- C. Prevent pipe from floating during backfill operations by properly installed supporting. Remove and replace segment of pipe which is distorted or moved from final line and grade.
- D. Secure supporting in place so that it cannot be dislodged during adjacent pipe laying and during grouting operations.
- E. Construct bulkheads of material, compatible with grout, to withstand imposed grout pressure without leakage. Provide bulkheads at frequency to allow completion of grouting in continuous operation and to permit timely removal of pipe and grout which may be needed as result of pipe distortion or movement. Modifications to bulkhead spacing will be reviewed by Engineer. Provide adequate venting for bulkheads.

3.8 ANNULAR GROUT

- A. Fill annular void between water line and tunnel primary liner or casing with grout, in accordance with Section 02431 - Tunnel Grout.
- B. Test annular grout material, equipment, and procedures in accordance with approved submittal. Perform test on first 200 feet of water line to be backfilled. When grout does not totally fill annular space or other problems occur, correct defects in first test section and adjust method or mix and rerun test on next 200 feet. Repeat procedure as necessary.
- C. Placement:
 - 1. Placement Limits: Predetermine limits of each grout placement stage by size and capacity of batching equipment and initial set time of proposed grout. Under no circumstances shall placement at grout port continue longer than period of time for mix to take initial set. Locate grout hole spacing and locations according to number of stages necessary to backfill tunnel liner. Do not install another lift until proper set has been attained. Placement procedures shall be approved by admixture or additive manufacturers.
 - 2. Equipment - Pumps: Pumping equipment must be of sufficient size and capacity to place grout to distances and volumes compatible with batching and mixing equipment. Maintain equipment and clean thoroughly each day. No hydrocarbons shall enter pumping chamber. Under no circumstances shall grout be pumped in excess of 1000 linear feet without prior approval by Engineer. Pumping test and verification testing of resulting grout quality will be required for approval.
 - 3. Slickline: Convey grout to point of placement in clean steel or rubber hoses designed to handle safely pump pressure and volumes during placement. Do not allow hardened grout or concrete to obstruct or coat steel pipe or hose internally.
 - 4. Grout Connections: Grout connections shall be sized minimum of 2-inch inside diameter, consisting of grout hose attached immediately to pressure gauge. Gauged pumping pressure shall not exceed water line manufacturer's recommendations. Monitor grout pressure.
 - 5. Gauges:
 - a. Type: Instrument oil-filled and attached to saddle-type diaphragm seal (gauge saver) to prevent clogging with grout.
 - b. Calibration: Certified and calibrated in accordance with ASME B 40.1.
 - c. Range: Not more than 100 percent greater than design grout pressure.

- d. Accuracy: No more than one-half percent error over full range of gauge.
- e. Fitting: Attach gauge to valve immediately attached to grout port in tunnel liner. Provide T-fitting in injection line for sampling.
- 6. Limit pressure on annular space to prevent damage to pipe or liner. Define limiting and estimated required pressure range. Provide and monitor open ended, high point tap or equivalent vent at bulkhead opposite point of grouting.
- 7. Pump grout until grout within 5 percent of specified density discharges from end opposite injection point to ensure grout is not diluted by extraneous water in annulus.
- 8. Drilling of access holes from surface to facilitate grouting shall not be allowed.
- 9. Communication: There shall be constant communications via telephone between headerman at point of injection and pump, batch plant, and supervisor. Under no circumstance shall grouting continue without continuity of communications.
- 10. The headerman at point of placement shall advise batch plant of variations of density and make corrections as necessary. Record and submit to Engineer for each days pour variations and corrections.
- D. Delay grouting until all significant differential movement has stopped as determined by monitoring.
- E. Remove bulkheads unless constructed of masonry.
- F. Repair or replace damage or distortion to water line.

3.9 GROUTING JOINTS

- A. Materials and procedures for filling interior joint recesses shall conform to Section 02511 - Water Lines.

3.10 AS-BUILT SURVEY AND INSTALLATION TOLERANCES

- A. Perform as-built survey on installed water line. Determine horizontal and vertical location for invert of each pipe joint.
- B. Acceptable tolerances: Within plus or minus 3 inches of horizontal alignment, within plus or minus 2 inches of vertical alignment.

- C. Correct pipe section outside acceptable tolerances.

3.11 FINAL CLEANUP

- A. Clean interior to pipe after interior work is completed. Remove loose material, dirt, and debris from completed pipeline. After completion of work inside pipe, prevent dirt, water, and other debris from entering until water line work is completed.

END OF SECTION

Section 02518

STEEL PIPE AND FITTINGS
FOR LARGE DIAMETER WATER LINES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Large diameter steel pipe and fittings for transmission lines and pumping facilities installed as part of the SWSP.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for steel pipe and fittings or testing requirements under this Section. Include cost in unit price for water lines, pumping facilities, and encasement sleeves.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.
- C. Stored Materials. Payment will be made for steel coil stored in the pipe production facilities under the following conditions.
 - 1. Payment will be made for 90 percent of the invoice amount for the steel coil less the specified retainage in accordance with the General Conditions.
 - 2. Invoices for steel coil must be provided for payment consideration.
 - 3. Provisions must be made by the pipe manufacturer to allow an inventory of steel coil each month while pipe is being manufactured and steel coil is added to or removed from inventory. Once the relationship between pipe manufacturing and coil usage is established, the Engineer may waive the requirement to check steel coil inventory for months when no coil is added to inventory.
 - 4. Transfer ownership of the material to the Owner in accordance with Section 01270 – Measurement and Payment.
 - 5. Contractor will provide a letter from the surety company agreeing to the

payment for steel coil under these conditions.

6. Contractor, at its expense, must provide insurance applicable to the storage of steel coil while in the Supplier's or Contractor's care, custody and control. Provide evidence of insurance verifying the coverage during all periods of storage.

1.3 REFERENCES

- A. AASHTO - Standard Specifications for Highway Bridges.
- B. AREMA - Manual for Railway Engineering, Volume II, Chapter 15.
- C. ASME Boiler & Pressure Vessel Code Section VIII – Rules for Construction of Pressure Vessels, Division I
- D. ASTM A 36 - Standard Specification for Structural Steel.
- E. ASTM A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- F. ASTM A 135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
- G. ASTM A 139 - Standard Specification for Electric-Fusion (ARC) - Welded Steel Pipe (NPS 4 and Over).
- H. ASTM A 1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- I. ASTM A 1018 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- J. ASTM C 33 - Standard Specification for Concrete Aggregates.
- K. ASTM C 35 - Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.
- L. ASTM C 150 - Standard Specification for Portland Cement, Type I or II.
- M. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- N. ASTM C 595 - Standard Specification for Blended Hydraulic Cements.

- O. ASTM C 881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- P. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
- Q. ASTM D16 – Standard Terminology for Paint, Coatings, Materials and Applications
- R. ASTM D 512 - Standard Test Methods for Chloride Ion in Water.
- S. ASTM D 552 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- T. ASTM D 1293 - Standard Test Methods for pH of Water.
- U. ASTM D 3363 - Standard Test Method for Film Hardness by Pencil Test.
- V. ASTM D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tests.
- W. ASTM D 4752 - Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub.
- X. ASTM F 436 – Standard Specification for Hardened Steel Washers
- Y. ASTM F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- Z. ASTM F 594 – Standard Specification for Stainless Steel Nuts
- AA. AWWA C 200 - Steel Water Pipe 6 in. and Larger.
- BB. AWWA C 205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe.
- CC. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
- DD. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.
- EE. AWWA C 208 - Dimensions for Fabricated Steel Water Pipe Fittings; Addendum C 208A.
- FF. AWWA C 210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.

- GG. AWWA C 213 – Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
- HH. AWWA C 216 – Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
- II. AWWA C 217 – Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
- JJ. AWWA C 222 – Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
- KK. AWWA C 602 - Cement-Mortar Lining of Water Pipelines - 4 in. (100 mm) and Larger - In Place.
- LL. AWWA C 604 – Installation of Buried Steel Water Pipe - 4 In. and Larger.
- MM. AWWA M 11 - Steel Pipe-A Guide for Design and Installation.
- NN. ISO 9001 – International Organization for Standardization, Quality Management.
- OO. SPFA – Steel Plate Fabricators Association
- PP. SSPC Good Painting Practice, Volume 1.
- QQ. SSPC SP 1 - Surface Preparation Specification No. 1, Solvent Cleaning.
- RR. SSPC SP 5 - Joint Surface Preparation Standard, White Metal Blast Cleaning.
- SS. SSPC SP 6 - Surface Preparation Specification No. 6, Commercial Blast Cleaning.
- TT. SSPC SP 10 - Surface Preparation Specification No. 10, Near-White Blast Cleaning.
- UU. SSPC VIS 1 - Visual Standard for Abrasive Blast Cleaned Steel.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings signed and sealed by Professional Engineer registered in State of Texas showing following:
 - 1. Manufacturer's complete pipe design and thrust restraint calculations based

on latest editions of AWWA M11, AWWA C 200, and the requirements of the Specifications.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, cylinder thickness, manufacturing tolerances, maximum angular deflection limitations of field joints, welding procedures, fabrication, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints, weld lead outlets and plugs, bulkheads, closure sections, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Engineer. Provide final approved lay schedule in Adobe portable document format (*.PDF) and in CAD format for incorporation into and compatible with WHCRWA GIS based on the WHCRWA monument system.
 3. Submit certification from manufacturer that design was performed for project in accordance with requirements of this section. Certification to be signed and sealed by professional Engineer registered in State of Texas.
- C. Submit manufacturer's certifications that pipe and fittings have been hydrostatically or by other nondestructive methods tested at factory in accordance with AWWA C 200, Section 5.2.
- D. Submit certification from NACE Certified Coatings Inspector, under supervision of inspector having Level III certification for coatings and linings, that steel pipe furnished on project was properly inspected and defective coatings detected properly repaired, along with coating manufacturer's catalog sheets, technical information sheets, material safety data, and material test reports for the selected coating. Also, include manufacturer's recommendations for preparation, application, curing and repair of coating.
- E. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit, at least 30 days prior to repair work, procedures that describe in detail shop and field work to be performed. Repair defects such as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, etc.
- F. Submit the following for non-shrink grout for special applications in accordance with Section 2.6 of this specification:
1. Manufacturer's technical literature including specifications for mixing, placing, and curing grout.
 2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C 1107, Non-shrink Grout and requirements of this

specification.

3. Certification product is suitable for use in contact with potable water.
- G. Submit proof of certification for welders in accordance with Specification 02511 – Water Lines. Indicate certified procedures and position each welder is qualified to perform. Provide documentation of the most recent weld qualification test date and continuity of use in each process for which the welder or welding operator is required.
- H. Within 45 calendar days after manufacturing of all pipe, submit affidavit of compliance that materials and work furnished comply with applicable requirements of referenced standards and these specifications. Submit a copy of physical and chemical testing reports.
- I. Within 45 days of manufacturing of all pipe, submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section and:
1. Polyurethane coatings were applied in accordance with manufacturer's recommendation applied and allowed to cure at temperature 5 degrees above dew point.
 2. Mortar coatings and linings were applied and allowed to cure at temperature above 32 degrees F.
 3. Test Results:
 - a. Compressive strength (7 and 28 day) test results for mortar coating.
 - b. Hydrostatic testing, magnetic particle and non-destructive weld test reports as required.
- J. Submit Weld After Backfill (WAB) Plan. Plan shall include the following:
1. Procedures for welding pipe joints.
 2. Heat shrink sleeve manufacturer, model, underlayment (sacrificial sleeve, if any), overlayment (if required due to backfill conditions). Submit technical data sheets that itemize technical and performance information and recommended application procedures. Submit a sample of heat shrink sleeve.
 3. Special installation techniques required, including:
 - a. Low heat welding procedure.

- b. Method of measuring pipe wall temperature within 3 inches of weld.
 - c. Method of assuring clearance between the bell and spigot faying surfaces (joint gap) does not exceed 1/8 inch maximum.
 - d. Written acceptance from the heat shrink sleeve manufacturer of the WAB Plan and written certification that the proposed material is intended for this application.
- 4. Repair plan and procedures for repairing damaged heat shrink sleeve and coating.
- K. Submit certification showing calibration within last 12 months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by Engineer.
- L. Submit Nominal Allowable Steel Wall Thickness calculations to Engineer for approval prior to ordering pipe.

1.5 QUALITY CONTROL

- A. Provide pipe as the product from a single manufacturer who has had not less than five (5) years successful experience manufacturing pipe, fittings and specials with coatings and linings as specified. Pipe manufacturing operations shall be performed at one location unless otherwise approved by Engineer. Fittings may be manufactured at an alternate location, provided they are supplied under the responsible authority of the pipe manufacturer, and the fittings manufacturer has not less than five (5) years successful experience and complies with certification requirements contained herein.
- B. The manufacturer of pipe and fittings shall be certified either under SPFA or ISO 9001 quality certification program for steel pipe and accessory manufacturing.
- C. Approved steel pipe manufacturers are as follows:
 - 1. American SpiralWeld
 - 2. Northwest Pipe
 - 3. Thompson Pipe Group
 - 4. Mid America Pipe
- D. Manufacturer to provide, and submit documentation for, permanent quality control department and laboratory facility capable of performing inspections and testing as required by specifications. Material testing, inspection procedures, and manufacturing process are subject to inspection by the Engineer. Perform manufacturer's tests and inspections required by referenced standards and these specifications, including the

following. Correct nonconforming conditions.

1. Steel Plate and Coils. Submit mill certifications for conformance to requirements of specifications; perform physical and chemical testing of each heat of steel for conformance to applicable ASTM standards.
2. Pipe:
 - a. Inspect thickness, circumference, roundness, strength and size of seam welds (spiral or longitudinal), and squareness of pipe ends to verify compliance with AWWA C200.
 - 1) Pipe roundness to be within $\pm 1\%$.
 - 2) Frequency of production weld tests in accordance with AWWA C200 Section 4.10.4.6. Conduct weld tests at a maximum interval of once per 3,000 feet of weld.
 - 3) Provide certified test reports for factory welds on fittings from a certified welding inspector that may be in-house or third-party.
 - b. Inspect physical dimensions and overall conditions of all joints for compliance with AWWA C200, approved submittals, and Specifications.
 - c. Hydrostatically test finished pipe section to 75 percent of specified minimum yield strength of steel being used with zero leakage. Pipe under test must be visually examined for a minimum of 2 minutes.
 - d. Perform Charpy V-Notch (CVN) Test in accordance with AWWA C200.
3. Linings:
 - a. Inspect unlined pipe for overall condition of inside barrel. Maintain inside barrel free of corrosive products, oil, grease, dirt, chemical, and deleterious material.
 - b. Inspect lined pipe for physical dimensions and overall condition of lining, visible surface defects, thickness of lining, and adhesion to steel surface (for polyurethane or epoxy lining).
 - c. Review certifications by manufacturers of lining components for conformance to AWWA standards and these Specifications.

4. Coatings: Measure temperature and dew point of ambient air before applying coatings; coating is not to be applied if the ambient temperature is less than 5 degrees Fahrenheit above the dew point. Inspect surface preparation per Specifications. Inspect physical dimensions and overall condition of coatings. Inspect for visible surface defects, thickness, and adhesion of coating to surface and between layers.
5. Final Inspection:
 - a. Before shipment, inspect finished pipe, fittings, specials and accessories for markings, metal, coating thickness, lining thickness (if shop applied), joint dimensions, and roundness.
 - b. Inspect for coating placement and defects. Test exterior coating for holidays.
 - c. Inspect linings for thickness, pitting, scarring, and adhesion.
 - d. Any deficiencies discovered through inspection must be repaired before shipping.
 - e. Damaged or defective pipe will not be allowed to be unloaded at the job site, and will be returned to manufacturer for repairs.
 - f. Ensure conformance with sections 3.1.B.2, 4, 5, 6, 9 of this specification.
- E. Shop-applied coatings and linings; provide services of qualified and certified coating and lining in house inspector, outside inspection service, or testing laboratory with qualified coating inspectors. Perform inspection by NACE trained inspectors under supervision of NACE Level III Certified Coatings Inspector.
- F. Ensure workmen engaged in manufacturing are qualified and experienced in performance of their specific duties.
- G. Cast four standard test cylinders each day for each 50 cubic yards of mortar coating or portion thereof for each coating and lining placed in a day. Perform compressive strength test at 28 days. Pipe lined or coated with mortar that has cylinders with test results less than or equal to 80% of ultimate strength will be rejected.
- H. Dented steel cylinders will result in rejection of pipe if they cannot be repaired per C200 and to the satisfaction of the Engineer. Contact Engineer prior to and after repair for approval of repair procedure and results of repair.

- I. Submit a copy of physical and chemical testing reports for steel cylinders and provide reports at request of Engineer.
- J. Check physical dimensions of pipe and fittings. Physical dimensions to include at least pipe lengths, pipe I.D., pipe O.D. and bend angles.
- K. Manufacturer's Technician Required for Pipe Installation
 - 1. During the construction period, the pipe manufacturer shall furnish the services of a factory trained, qualified, job experienced technician to advise and instruct the Contractor and Owner's Inspector's as necessary to assure the proper handling, storage, joint assembly, lining and coating repair of the pipe. The technician shall advise the Contractor in his pipe laying operations and shall instruct construction personnel in proper joint assembly and joint inspection procedures. The technician (s) shall be on-site full time during the first two weeks of pipe laying for each separate laying crew and thereafter as requested by the Owner's Inspectors.
 - 2. The pipe manufacturer shall provide services of the coating manufacturer's qualified representative(s) and a qualified representative(s) from the heat shrink sleeve manufacture of a period of not less than two weeks at the beginning of actual pipe laying operations for each separate laying crew to advise Contractor and Owner's Inspector's regarding installation including handling and storage, cleaning and inspecting, coating repairs, field applied coating, heat shrink installation procedures and general construction methods and how they may affect the pipe coating.
 - 3. The manufacturer's representative shall be required to return if, in the opinion of the Owner's Inspectors, the coating, lining, or the Contractor's construction methods do not comply with the Contract Documents.

1.6 INSPECTION

- A. Engineer may witness manufacture and fabrication of pipe and appurtenances. Independent testing laboratory under contract to Engineer may perform tests at direction of Engineer to verify compliance with these specifications. Provide assistance to accomplish such testing, including equipment and personnel, at no additional cost to Authority.
- B. Engineer shall have access to the work whenever it is in preparation or progress, and the pipe manufacturer shall provide proper facilities for access and for inspection. The pipe manufacturer shall notify the Engineer in writing, a minimum of three (3) weeks prior to each of the pipe fabrication runs so that the Engineer may advise the manufacturer as to the Engineer's decision regarding tests to be performed by an independent testing laboratory. Material, fabricated parts, and pipe, which are

discovered to be defective, or which do not confirm to the requirements of this Section shall be subject to rejection at any time prior to Engineer's final acceptance of the product.

PART 2 P R O D U C T S

2.1 STEEL PIPE

- A. Furnish pipe, fittings, coating and linings all by one manufacturer and produced in one facility. Do not ship over salt water.
- B. Fabricate and supply miscellaneous steel pipe and fittings in accordance with AWWA C200, C207, C208 and AWWA M11 except as modified herein. Steel to be minimum of ASTM A 36, ASTM 1018 Grade 36, ASTM A 53 Grade B, ASTM A 135 Grade B, ASTM A1011 or ASTM A 139 Grade B.
- C. The welding procedures used to fabricate the pipe and the welding operators and welders shall meet the requirements of and be qualified under the provisions of ASME/BPVC Section IX, AWS B2.1 or AWS D1.1.
- D. Pipe section length:
 - 1. For water lines greater than 60-inches provide pipe sections in lengths no greater than 50 feet. Field conditions such as existing buried utilities or limited lay-down or stringing storage space may preclude the use of longer laying length pipe. Contractor shall coordinate with the pipe manufacturer as to the pipe nominal laying length to address these conditions.
 - 2. For water line diameters 60-inches and smaller provide pipe sections no greater than 50 feet and not less than 20 feet except as required for special fittings or closure sections unless otherwise approved by the Engineer.
 - 3. Provide closure sections and short sections of steel pipe not less than 4 feet in length unless indicated on Drawings or specifically permitted by Engineer.
- E. Wood Stulls:
 - 1. All lumber for stulls must be cured wood. Vertical stull shall be 4-inch x 6-inch lumber (min.); cross stulls shall be 4-inch x 4-inch lumber (min.). Connect stulls with bolts. Stull contact with pipe liner with a 4-inch x 6-inch or larger lumber "shoe" shaped to conform to pipe diameter. Lumber 'shoe' shall be a minimum length of 24 inches. Shim as needed to maintain tight fit and roundness of pipe.
 - 2. Install stulls in 30-inch and larger pipe, specials, and fittings in accordance with approved submittal and as soon as practical after pipe is fabricated or for shop lined pipe after lining has been applied. Six point

stulls shall be equally spaced circumferentially (approximately 60-degree spacing) within the pipe. Maximum spacing of stulls is 15 feet.

3. Install stulls in a manner that will not harm lining.
- F. Provide shop-coated and shop-lined steel pipe with minimum of one coat of shop-applied primer approved for use in potable water transmission on all exposed steel surfaces. Provide primer compatible with coating system and in accordance with coating manufacturer's recommendations.
- G. Square flanges with pipe to be supplied with bolt holes straddling both horizontal and vertical axis. Provide 1/2-inch gap between pipe ends to be coupled with sleeve coupling unless otherwise indicated on Drawings.
1. Provide standard ring flanges, conforming to AWWA C207, Class D.
 2. Apply Denso petroleum-based tape or approved equal to exposed portions of nuts and bolts.
- H. Pipe Design Conditions:
1. Design: Design pipe and fittings in accordance with AWWA Manual M11 and AWWA C 208, to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading or AREMA E-80 loads as appropriate and depths of bury as indicated on Drawings. Design pipes with Marston's earth loads for transition width trench for all heights of cover.
 2. Groundwater Level: Design for most critical ground water level condition.
 3. Working pressure = 150 psi.
 4. Hydrostatic field test pressure = 150 psi.
 5. Maximum total pressure due to surge = 225 psi.
 6. Minimum pressure due to surge = -14.7 psi.
 7. Modulus of elasticity (E) = 30,000,000 psi.
 8. Maximum deflection from specified diameter:
 - a. Two percent (2%) for mortar coating pipe where allowed in Drawings for all loading conditions including future loading conditions;
 - b. Three (3)% for polyurethane coating pipe for all loading conditions

including future loading conditions.

9. Design stress due to working pressure to be no greater than 50 percent of minimum yield, and stress not to exceed 18,000 psi for mortar coated pipe and 21,000 psi for polyurethane coated steel pipe.
10. Design stress due to maximum hydraulic surge pressure to be no greater than 75 percent of minimum yield, and stress not to exceed 27,000 psi for mortar coated pipe.
11. Modulus of soil reaction (E'):
 - a. Steel Waterline in Open-cut: 1,500 psi for typical embedment trench section.
 - b. Steel Waterline in Tunnel: 2,500 psi when all annular space is grouted per Specifications between the pipe, initial support, and undisturbed in situ soil.
12. Unit weight of fill (w) > 130 pcf.
13. Deflection lag factor (D1) = 1.1.
14. Bedding constant (K) = 0.1.
15. Fully saturated soil conditions: $hw = h$ = depth of cover above top of pipe.
16. Pipe Wall Thickness: For buried pipe or pipe in casing, do not allow nominal diameter (D) over wall thickness (t) ratio to be greater than 230. For non-buried pipe (inside a vault or aerial crossing), minimum pipe wall thickness shall be 0.25 inches, or D/144, whichever is greater.
17. Provide minimum inside clear diameter for tunnel liners or casing in accordance with Tunnel Specifications and Drawings.
18. Exclude structural benefits associated with primary liner in design of pipe in tunnel installations:
 - a. Design pipe and joints to carry loads including overburden and lateral earth pressures, subsurface soil and water loads, grouting, other conditions of service, thrust of jacks, and stresses anticipated during handling and construction loads during installation of pipe.
 - b. Do not use internal removable stiffeners for pipe in tunnel, unless approved by Engineer.
 - c. External welded steel stiffeners will be permitted in design

calculations for steel pipe, provided wall thickness is minimum of 0.1875 inch. Minimum clearances specified between exterior pipe wall and tunnel liner applies to distance between outside diameter of external welded stiffener and tunnel liner.

- I. Fittings for Water Lines: Fabricate in accordance with AWWA M11, and AWWA C208.
 1. Wall Thickness: Equal to or greater than pipe to which fitting is to be welded.
 2. Elbows: 2-piece for 0 degrees to 22-1/2 degrees; 3-piece for 23 degrees to 45 degrees; 4-piece for 46 degrees to 67-1/2 degrees; and 5-piece for 68 degrees to 90 degrees, unless otherwise shown on Drawings. Radius: Minimum radius of two and one-half times pipe diameter unless otherwise approved by Engineer.
 3. Outlets: Reinforced in accordance with AWWA M11, Chapter 9, AWWA C200, and AWWA C208. Provide interior lining and exterior coating in accordance with paragraphs on coating and lining and matching pipe to access inlets, service outlets, test inlets, and air-vacuum valve and other outlets, including riser pipes.
 4. Butt Straps for Closure Piece: Minimum 12-inch-wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated using material listed in Paragraph 2.01 C to thinnest member being joined. Plain ends beveled as required by AWWA C200. Provide minimum lap of 4 inches between member being joined and edge of butt strap, welded on both inside and outside, unless otherwise approved by Engineer. Provide minimum 6-inch welded outlet for inspecting each closure section, unless access manway is within 40 feet of closure section.
 5. Reducers: Provide in accordance with AWWA M11 and AWWA C208.
 6. Dished Head Plugs: Design in accordance with ASME Boiler & Pressure Vessel Code, Section VIII, Division 1, latest edition. Design to withstand field hydrostatic test pressure from either side of plug. Design stress due to hydrostatic pressure to be no greater than 50 percent of minimum yield. Pipe on opposite side of hydrostatic test may or may not contain water. .
- J. Joints:
 1. Joints are to be lap-welded slip type in accordance with AWWA C200, except where flanged joints or butt strap joints are required. All 66-inch and greater

steel pipe joints are to be lap welded with interior welds unless shown differently on Drawings.

2. Provide welded butt joints on above-ground piping, tee fitting supported on pier foundation, field welds for risers including vertical portion of crossover piping, and where noted on Drawings.
 3. Joints shall be designed to withstand jacking forces.
 4. Design restrained joints for test pressure or maximum surge pressure as specified, whichever is greater.
 5. Provide full circumferential welds at joints required to be welded.
- K. Perform x-ray, ultrasonic, magnetic particle, or dye penetrant testing per AWWA C200 of manual welds on special pipe and fittings.
- L. Hydrostatic Testing of Pipe:
1. AWWA C200, Section 5.2.1, at point of manufacture. Hold test pressure for minimum 2 minutes and conduct thorough visual inspection of entire weld length on pipe. Repair or reject pipe revealing leaks or cracks.
 2. Calibrate pressure gauges within one year prior to testing as specified in Section 1.4.K.
- M. Provide outlets for weld leads may be factory fabricated flanged outlets for weld leads or as 6-inch pass through as shown in Drawings. Outlet's opening shall be a minimum 6-inch diameter. All flanged weld outlets shall be welded shut to prevent leaking. Encase the outlet in cement mortar. All bolts, nuts, and flange gaskets if required shall conform to Specifications. Minimum spacing for outlet leads shall be 500 feet. Access through other appurtenances shall be included in the calculation for 500-foot minimum spacing.
- N. Flanges:
1. Refer to Section 02511 – Water Lines.
- O. Make curves and bends by deflecting joints, or by using mitered joints, or by combination of two methods, unless otherwise indicated on Drawings or permitted by Engineer. Do not exceed deflection or joint offset angle at joint as recommended by pipe manufacturer. Make penetration of spigot into bell at all points of circumference at least equal to minimum required penetration shown on Drawings. Mitered pipe sections used in curved alignment to be of standard length except when shorter sections are required to limit radius of curvature, in which case all sections

throughout curve are to be of equal length. Do not allow miter to exceed 5 degrees.

2.2 INTERNAL LINING SYSTEMS FOR STEEL PIPE, ALL INSTALLATIONS

- A. Supply steel pipe with cement-mortar lining, capable of conveying water at temperatures not greater than 140 degrees F.
- B. For all exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, provide epoxy or polyurethane lining, as specified, unless otherwise noted or that may interfere with sealing surfaces.
- C. Provide linings, bonding agents, and admixtures conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61, and certification to be from organization accredited by ANSI.
- D. Epoxy Lining:
 - 1. AWWA C210, color White, Light Grey or Off-White, or approved equal otherwise approved by Engineer. To be applied in factory. Perform field repairs in accordance with manufacturer's recommendations. Submit field repair procedures to Engineer for review. Provide materials from same manufacturer.
 - a. Protect interior surface with 100% solids, liquid two-part chemically cured epoxy coating specified for interior surfaces.

Surface Preparation	SSPC-SP10 Near White Blast Clean surface profile.
Finish Coat	AWWA C210. Provide Plasite 4500 S or approved equal

- 2. Provide 20 mils dry film thicknesses, or greater, in accordance with product's manufacturer recommendations. Do not exceed maximum DFT as recommended by manufacturer.
- 3. Factory testing: In accordance with AWWA C210.
- E. Shop-applied Cement-mortar Lining (for pipe $\leq$ 120 inches in diameter):
 - 1. AWWA C205; except as specified herein: $\frac{3}{4}$ -inch minimum thickness for pipe diameters 84-inches and larger, $\frac{1}{2}$ -inch minimum thickness for pipe diameters 42 inches to 72-inches; $\frac{3}{8}$ -inch minimum thickness for pipe

diameters 36 inches and smaller. Cut back lining from joint ends no more than 2 inches to facilitate joining and welding of pipe.

2. Apply cement-mortar lining to inside of pipe by centrifugally spinning. For special sections (shape of which precludes application by spinning method) accomplish by mechanical placement or pneumatic placement and finish to produce smooth, dense surface comparable to centrifugally spinning.
3. Use galvanized wire mesh when shop-applied mortar is not applied by machine. Do not extend wire mesh across welded portion of mitered fittings. Crimp mesh to provide integral “chair” so wire does not fully rest against steel cylinder.
4. Make repairs of cement-mortar lining for widths exceeding 6 inches by bonding to steel and adjacent faces of lining with bonding agent conforming to ASTM C 881, Type II.
5. Restrict usage of sprinkler heads during moist curing to prevent over-spraying onto lining. No alternative curing methods are allowed.
6. Satisfy Engineer that above requirements can be accomplished by manufacturer prior to shipment of pipe.

F. Shop-applied Polyurethane Lining

1. Only use polyurethane lining as indicated on Drawings. Comply with requirements in AWWA C222 and Section 02527 – Polyurethane Coating for Steel or Ductile Iron Pipe.

2.3 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE-GROUND AND IN VAULTS (EXPOSED)

- A. Provide approved epoxy/polyurethane coating system as designated below. Provide materials from same manufacturer.

Surface Preparation	SSPC SP 10 Near White Blast Clean surface profile as recommended by manufacturer

Intermediate Coat	Chemical Resistant Epoxy, or approved equal DFT as recommended by manufacturer
Finish Coat	Polyurethane, or approved equal DFT as recommended by manufacturer

- B. Total Allowable Dry Film Thickness for System: as recommended by manufacturer.
- C. Factory testing: In accordance with AWWA C210.

2.4 EXTERNAL COATING SYSTEMS FOR BURIED STEEL PIPE

- A. Polyurethane Coating: Supply pipe with shop-applied polyurethane coating. See Section 02527 – Polyurethane Coatings for Steel or Ductile Iron Pipe for requirements for use of polyurethane.
- B. Cement-mortar Coating: Supply pipe with cement-mortar coating **only** if indicated on the Contract Drawings. Cement-mortar coating shall be in accordance with AWWA C205, shop-applied, except as modified in this Section. Provide coating with 1-inch minimum thickness. Cut back coating from joint ends no more than 2 inches to facilitate joining and welding of pipe.
- C. Heat Shrink Joint Sleeves for Polyurethane Coating: Provide heat shrink, cross-linked polyolefin wrap or sleeve with a mastic sealant, 85 mils total thickness, suitable for pipeline operating temperature, in accordance with AWWA C216. Provide Aqua-Shield by Canusa-CPS, Covalence by Seal for Life, or approved equal.
 - 1. Where weld after backfill procedures are used, conform to manufacturer's recommendations for installation.
 - 2. Provide primer as recommended by the heat shrink sleeve manufacturer.
 - 3. Mastic filler shall be provided for all bell and spigot and coupling type joints. Filler material shall be intended for WAB application, compatible with the heat shrink sleeves, nonflammable, and must adhere to the pipe and heat shrink sleeve.
 - 4. Width of heat shrink sleeves shall be 17-inches minimum or sufficient to overlap existing finished pipe coating 4-inches minimum on each side of joint, whichever provides greater overlap. Provide adequate sleeve width to

account for shrinkage due to installation and joint profile. High recovery sleeve shall be provided for bell and spigot and coupling style joints with a minimum of 50 percent recovery.

5. If recommended by the heat shrink sleeve manufacturer, provide a 6-inch underlayment sleeve (sacrificial sleeve), cross linked polyolefin wrap or sleeve with a mastic sealant, with 85 mils nominal thickness.

- D. Provide shop-applied primer on coating holdback areas at joint in accordance with Holdback Coating System requirements in Section 02527 – Polyurethane Coatings for Steel or Ductile Iron Pipe.

2.5 EXTERNAL COATING SYSTEM FOR STEEL PIPE IN TUNNEL, CASING

- A. For water lines in tunnel where annular grout will be used, shop coat external surfaces of steel pipe with epoxy in accordance with Paragraph 2.3 of this Section, or polyurethane in accordance with Specification Section 02527 – Polyurethane Coatings for Steel or Ductile Iron Pipe.

2.6 GROUT FOR JOINTS AND SPECIAL APPLICATIONS

- A. Cement Grout Mixture: One part cement to two parts of fine, sharp, clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream. Mix cement grout to specific gravity of 19 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of Engineer. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.

1. Portland Cement: ASTM C 150, Type II. Provide one type of cement for entire project.
2. Sand:
 - a. Interior Joints: ASTM C 35 fine graded plaster sand.
 - b. Exterior Joints: ASTM C 33; natural sand with 100 percent passing No. 16 sieve.
3. Water: Potable water with total dissolved solids less than 1000 mg/l; ASTM D 512 chloride ions less than 100 mg/l for slurry and mortar cure; ASTM D 1293 pH greater than 6.5. Use potable water with 250 ppm limit on chlorides

and sulfates.

- B. Provide approved Non-shrink Grout for Special Applications, Patches and Repairs.
1. Conform to requirements of ASTM C 1107, Non-shrink Grout.
 2. Pre-blended factory-packaged material manufactured under rigid quality control, suitable for use in joints of pre-stressed concrete cylinder pipe.
 3. Contain non-metallic natural aggregate and be non-staining and noncorrosive.
 4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.
 5. Compressive Strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.
 6. Non-bleeding and non-segregating at fluid consistency.
 7. Contain no chlorides or additives which may contribute to corrosion of steel pipe.
 8. Free of gas-producing, gas-releasing agents.
 9. Resist attack by oil or water.
 10. Mix, place, and cure in accordance with manufacturer's instructions and recommendations. Upon 72 hours' notice, provide services of qualified representative of non-shrink grout manufacturer to aid in assuring proper use of product under job conditions. Representative to be on site when product is first used.
 11. Mix cement grout to specific gravity of 17.7 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of Engineer. Add additional cement grout to mixed cement grout or water to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.
 12. Compressive Strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.
- C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to

remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

- D. Joint Wrapper: Minimum width of 9 inches for 33-inch diameter and smaller; minimum width of 12 inches for diameters greater than 33-inch hemmed at edge to allow threading with minimum 5/8-inch-wide steel strap. Provide minimum 6-inch-wide Ethafoam strip sized, positioned, and sewn such that two circumferential edges of Ethafoam are 1-1/2-inches from outer edge of wrapper.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

- A. Conform to applicable provisions of Section 02511 - Water Lines, except as modified in this Section
- B. Comply with following:
 - 1. Make available services of manufacturer's representative when deemed necessary by Engineer. Representative to advise in aspects of installation, including but not limited to handling and storing, cleaning and inspecting, coating and lining repair, and general construction methods as applicable to pipe.
 - 2. Handling and Storage: Install padded struts or stulls prior to shipping, horizontally and vertically, as proposed by manufacturer and approved by Engineer. Spiders: Installed in joint ends of fittings. Stulls to remain in place, horizontally and vertically positioned under following conditions:
 - a. During storage and shipping.
 - b. Until backfill is placed to ground level.
 - 3. Install stulls prior to shipment of pipe, bends, and fittings to prevent deflection during shipment, handling and installation. Provide stulls consisting of timber struts with end blocks shaped to fit curvature of interior surface of pipe or other appropriate configuration and material. Firmly edge and secure stulls to blocks so that they will remain intact position during handling and installation. Provide stulls adequate to resist handling loads encountered without structural failure to stull members or damage to pipe.
 - 4. Repair and/or reject and remove from site pipe that arrives at site with defects in lining, including sand pockets, voids, and over-sanded areas. Repairs must be made to the satisfaction of the Engineer to be accepted.

5. Store pipe at job site with securely fastened plastic endcaps to maintain moist pipe interior.
6. Bedding and Backfilling:
 - a. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
 - b. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.
 - c. Take necessary precautions during bedding and backfilling operations to prevent deformation or deflection of cylindrical shape of pipe by more than allowable pipe deflection. Do not move trench support system (trench safety system) once bedding material is compacted. Bedding disturbed in this way will be required to be removed and recompacted.
 - d. Excavate outside specified trench section for bell holes, and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlarge bell holes as required or directed by Engineer. Subsequent backfilling thereof will not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of Engineer.
 - e. Stulls may be removed 24 hours after backfill is placed to pavement or natural ground.
7. Pipe Deflection: After backfill is complete, test pipe for excessive deflection by measuring actual inside vertical diameter. For maximum deflection allowable, see Section 2.1.
 - a. Deflection may be measured by Engineer at location along pipe. Arithmetical averages of deflection are not acceptable.
 - b. If deflection exceeds that specified, do one of the following, as directed by Engineer:
 - 1) Remove backfill and side support. Re-round the pipe and properly replace compacted backfill and side support. Review cement mortar lining to assure that no harmful damage has occurred.

- 2) Remove entire portion of deflected pipe section and install new pipe at no additional cost to Authority.
 8. Move pipe in such manner not to damage pipe or coating. Do not roll pipe nor drag on ground. Use a minimum of two wide non-abrasive slings or belts to lift and lower pipe. Handle pipe using a spreader bar. Provide adequate spacing of pipe supports to prevent cracking or damage to lining or coating. Inspect and repair coating abrasions before pipe is lowered into trench.
 9. Use of dogs, clips, lugs, or equivalent devices welded to steel pipe for purpose of forcing it into position will not be permitted unless approved by Engineer. Remove foreign matter and protective material from surfaces that are to be in contact at joints. Leave surfaces of joint areas thoroughly clean for metal-to-metal contact of field joints.
- C. Static Electricity:
1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.
 2. Electrically test where required after installation of pipeline is complete.
- D. Surveying:
1. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by Engineer, and submit copy of data to Engineer at end of that day.
 2. Survey data to include unique pipe number, deflection or offset angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom, and at springline (each side).
 3. Survey data to include GPS coordinates for each pipe joint, located at the 12 o'clock position (top of pipe joint). Coordinates shall be based on WHCRWA survey datums. Pipe joints through tunnel casings or liners will not be located; however, the ends of tunnel casings or liners (beginning and end of tunnel) shall be located with GPS coordinates.
- E. Any time that laying of additional pipe is stopped for more than eight hours, plug ends of installed pipe and take proper precautions against flotation of pipe segments. Contractor is responsible for repair and replacement of all pipe that is floated.

3.2 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE GROUND AND IN VAULTS (EXPOSED) AND EPOXY INTERNAL LINING SYSTEM

- A. Safety: Paints, coatings, and linings specified in this Section are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for personnel involved in painting, coating, and lining operations.
- B. Workmanship:
 - 1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.
 - 2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.
- C. Surface Preparation:
 - 1. Use abrasive blasting to prepare surfaces.
 - 2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.
 - 3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP 1.
 - 4. Metal and Weld Preparation: Remove surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter by grinding to 1/4-inch minimum radius.
 - 5. Abrasive Material:
 - a. Blast only as much steel as can be coated within same day of blasting.
 - b. Use sharp, angular, properly graded abrasive capable of producing depth of profile specified herein. Transport abrasive to jobsite in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.
 - c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-TEX Coarse or Extra Coarse Press-O-Film Tape, or approved equal. Furnish tapes to Engineer.
 - d. Do not blast if metal surface may become wet before priming

commences, or when metal surface is less than 5 degrees F above dew point.

6. Evaluate degree of cleanliness for surface preparation with use of SSPC Pictorial Surface Preparation Standards for Painting Steel Surfaces, SSPC-Vis 1.
7. Remove dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air. Test cleanliness by placing 3/4-inch by 4-inch piece of clear Scotch-type tape on blasted surface, then removing and placing tape on 3x5 white index card. Reclean areas exhibiting dust or residue.

D. Coating and Lining Application:

1. Environmental Conditions: Do not apply when metal temperature is less than 50 degrees F; when ambient temperature is less than 5 degrees F above dew point; when expected weather conditions are such that ambient temperature will drop below 40 degrees F within 6 hours after application; or when relative humidity is above 85 percent. Measure relative humidity and dew point by use of sling psychrometer or similar in conjunction with U.S. Department of Commerce Weather Bureau Psychrometric Tables. Provide dehumidifiers for field-applied coatings and linings to maintain proper humidity levels.
2. Application Procedures:
 - a. Apply in accordance with manufacturer's recommendations and requirements of this Section. Provide finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive overspray, or delaminations.
 - b. Discard catalyzed materials remaining at end of day.
3. Thoroughly dry pipe before primer is applied. Apply primer immediately after cleaning surface. Apply succeeding coats before contamination of undersurface occurs.
4. Cure minimum of 24 hours at 77 degrees F before successive coats are applied. During curing process, provide forced-air ventilation in volume sufficient to maintain solvent vapor levels below published threshold limit value. Apply successive coats within recoat threshold time as recommended by coating or lining manufacturer on printed technical data sheets or through written communications. Brush blast joints of pipe which have been shop primed and are to receive intermediate and finish coats in field prior to

application of additional coats. After interior coats are applied, provide forced-air ventilation in sufficient volume and for sufficient length of time to ensure proper curing before filling pipe with water.

3.3 EXTERNAL COATING SYSTEM FOR BURIED STEEL PIPE

A. Polyurethane Coating System:

1. Conform to requirements of Specification Section 02527 – Polyurethane Linings and Coatings for Steel or Ductile Iron Pipe.
2. Heat Shrink Joint Sleeves:
 - a. Provide field-applied shrink-wrap coating system for coating field joints, tie-ins and other field welded joints. Apply heat-shrink sleeves prior to internal welding of pipe using approved procedure compatible with coating system. Install heat-shrink joint sleeves in accordance with manufacturer's recommendations. Provide services of technical representative of manufacturer available on site at beginning of pipe laying operations for each separate laying crew.. Representative to advise Contractor and Engineer regarding installation, repairs, and general construction methods.
 - b. Width of heat shrink sleeves shall be 17 inches minimum, or sufficient to overlap finished pipe coating 4 inches each side of joint, whichever provides greater overlap.
 - c. Heat shrink sleeves for field joint coating shall be compatible with the shop-applied coating system.
 - d. If recommended by heat shrink sleeve manufacturer, provide sacrificial heat shrink sleeve. Width of sacrificial heat shrink sleeve shall be as recommended by manufacturer.
 - e. Protective Overlayment:
 - 1) Where backfill material in vicinity of heat shrink sleeve will contain aggregates $\frac{3}{4}$ inch in size or greater, provide a protective overlayment to protect the heat shrink sleeve from damage.
 - 2) Protective overlayment material shall be compatible with the heat shrink sleeve, capable of withstanding the heat of welding, nonflammable, and in accordance with shrink sleeve manufacturer's recommendations.

3. Do not expose heat-shrink joint sleeves to harmful ultraviolet light for longer than recommended by the coating manufacturer.
4. At option of Engineer, coating system and application may be tested and inspected.

3.4 JOINTS AND JOINTING

A. Welded Joints:

1. For welded lap joints, conform to requirements of Section 02511 - Water Lines.
2. Butt joints to be complete penetration for entire circumference.
3. In addition to the weld test requirements of Section 02511 – Water Lines, all welds will be tested by the Authority’s materials testing consultant.

B. Flanged Joints: Conform to requirements of Section 02511 - Water Lines.

C. Joint Grouting and Testing: Conform to requirements of Section 02511 - Water Lines.

3.5 WELD AFTER BACKFILL (WAB)

A. Unless otherwise indicated on the Contract Drawings, weld pipe joints after completing pipe backfill. Welding procedure shall comply with the latest requirements for coating protection, holdback coating temperature resistance, and heat input monitoring.

B. Welding of joints shall comply with the requirements of this specification section and Section 02511 – Water Lines.

C. Welding speed, amperage, and voltage shall be controlled to ensure the maximum heat input will not result in a sustained surface temperature that exceeds the maximum allowable temperature recommended by the heat shrink sleeve manufacturer or 500° F at the coating/steel interface.

D. Quality Control for Weld After Backfill (WAB):

1. Testing Program: A testing program will be implemented on sections of pipe installed to verify that the combined coating system and welding procedure (WAB) produce results which meet the project requirements. This testing program will be performed in the field using actual construction installation

conditions. Contractor must show that the operation will not damage the joint coating system to the Engineer's satisfaction. The testing program will also verify the welding procedure and certify individual welders to perform the Work for this project.

2. Temperature Verification: During performance of the testing program, the interior steel temperature will be measured along the weld using an infrared thermometer to determine highest interior weld temperature which produced the successful WAB result using the proposed welding procedure. This temperature will be taken approximately 3 inches below the actual welding arc, concurrent with the welding and documented for future reference. This documented temperature will be the maximum limit allowed for the welders using this welding procedure. The Engineer will perform random weld temperature verifications concurrent with the welding to ensure the welding is being performed as required.
3. Weld procedures for WAB shall meet the heat limitations of the proposed coating system. The weld procedure shall be developed with the coating manufacturer to verify compatibility of the systems.
4. Testing Program
 - a. Each proposed welder for the project shall demonstrate their ability to perform joint welding that complies with the welding requirements, including weld profile, penetration depth, travel speed control and temperature control.
 - b. Each proposed welder for the project shall successfully perform a minimum of two separate field joint welds on coated and backfilled joints. Each weld shall be a minimum of 1/4 of the pipe circumference and located in the upper half of the pipe. Each welder shall be qualified using one pipe joint.
 - c. All welds shall be performed using the welding procedure developed as noted above.
 - d. The following information shall be recorded for each joint tested:
 - 1) Welder's name.
 - 2) Weld procedure to be used.
 - 3) Voltage setting of the welder.

- 4) Amperage setting of the welder.
 - 5) Average electrode travel speed (inches per minute).
 - 6) Calculation of the Heat Input in Joules to the weld using the following equation: Amperage (I) x Voltage (E) x 60 = Heat Input in Joules Travel Speed (V).
 - 7) Steel “pipe can” temperature measurements at 32nd circumference points (11.5 degree increments) around the circumference of the joint. Temperatures can be recorded by “heat stick” methods or digital infrared thermometer. Temperatures shall be measured at the following locations:
 - i At the weld immediately following the welder’s completion of the weld.
 - ii At 1 inch, 2 inches, and 3 inches from the weld, on each side of the weld, during the welding process.
- e. Weld Test Procedure:
- 1) The Engineer and the Authority will inspect the welded joints and perform tests to confirm compliance with AWWA C206 Standard.
 - 2) The Engineer shall designate the pipe joints (and adjoining pipe sections) to be tested.
 - 3) Each welder shall be required to successfully complete two separate field joint welds, as noted in Paragraph 3.5.D.4.b above, using the approved WAB Plan.
 - 4) If either of the welder’s two field test welds fail to meet the performance requirements, the Contractor may either, disqualify the welder, or along with the heat shrink sleeve Manufacturer, re-evaluate the WAB Plan procedures and revise those procedures to better address conditions in the field.
 - 5) If Contractor elects to revise the WAB Plan, said plan shall be submitted to Engineer for review and approval prior to further welding activities. If required by the Engineer, all

- proposed welders shall be retested using the new WAB plan requirements.
- 6) Contractor may request permission from Engineer to allow up to one previously disqualified welder to be retested. Engineer reserves right to reject such request.
 - 7) Sleeve Testing: Contractor shall exhume the designated pipe joints. Engineer will perform a visual inspection and perform destructive and non-destructive tests in accordance with AWWA C216 and C222 to confirm there was no damage to the heat shrink sleeve or adjacent coatings.
 - i Sleeves shall have no visible burns.
 - ii Sleeves shall not have excessive wrinkles.
 - iii Sleeves shall have no holidays.
 - iv Sleeves shall have no areas of disbonded coating or disbonding of the heat shrink sleeves except for the limited carbonized zone described above.
 - 8) Where the WAB joint has passed the visual inspection, it shall be tested using adhesion pull testing methods as defined in AWWA C216-15. Adhesion testing shall be performed at a point 2 inches from the center of the weld. Results of the testing shall be recorded and evaluated as follows:
 - i Record all adhesion pull test data.
 - ii Determine the minimum field adhesion from two “passing” (visual inspection) pipe joints.
 - iii Compare this minimum value to AWWA C216-15 recommended value of 15 lbs. /in width.
 - iv All coated pipe where the test results are less than the AWWA C-216-15 recommended value shall be rejected or repaired.
 - 9) Contractor will be required to exhume enough joints to verify the performance of each proposed welder, for examination and testing (min. 1 joint per welder).
 - 10) Joints to be exhumed will be selected by the Engineer and the Authority at their discretion.

- 11) Testing will be comprised of visual inspection and non-destructive electrical holiday tests.
 - 12) Destructive testing will be performed if visual or electrical holiday tests indicate a compromised coating.
 - 13) If it is found that the Contractor's welding procedure damages the heat shrink sleeve coating system:
 - i The Contractor will be required to modify the welding procedure or replace its welding personnel, depending on the cause of the failure, to the satisfaction of the Engineer. In addition, the Engineer may require welders to be retested.
 - ii The Engineer is entitled to require Contractor to exhume up to 10 additional joints for additional examination and testing.
 - iii Additional joint exhumation, testing, and repairs shall be at no additional cost to the Authority.
- f. On-Going Testing: Engineer is entitled to audit joint installation performance throughout the Project by requiring Contractor to exhume up to three joints per 5,000 feet of pipeline to be selected by the Engineer for inspection and testing. Requirements for on-going testing are separate from requirements for additional heat shrink sleeve inspections noted in paragraph 3.5D.4.e.13.ii above. Pipe joints selected for on-going testing will not be within the limits of tunneling.
- g. Contractor shall make all necessary repairs to coatings or sleeves resulting from defective installation or caused during exhumation of joints for testing at no additional cost to the Authority.
- h. Joint heat shrink sleeves that are found to have installation defects or were subjected to destructive tests shall be completely removed and replaced at no additional cost to the Authority.

3.6 COATINGS AND LININGS INSPECTION RESPONSIBILITIES

- A. Contractor is responsible for quality control of coatings and linings applications and testing and inspection stipulated in this Section. Engineer is responsible for quality assurance and reserves right to inspect or acquire services of independent third-party inspector who is fully knowledgeable and qualified to inspect surface preparation and application of high-performance coatings at phases of coatings and linings, field- or

shop-applied. Contractor is responsible for proper application and performance of coatings and linings whether or not Engineer provides such inspection.

- B. Cement Mortar Lining and Joint Finish: Finished surface of lining and joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

3.7 FIELD REPAIR PROCEDURES AND SPECIAL FITTINGS APPLICATION FOR CEMENT MORTAR LINING

- A. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with non-shrink grout. Repair defects by cutting out unsatisfactory material and replacing with non-shrink grout, securely bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off grout flush with surrounding surface.
- B. Areas greater than 6 inches in diameter:
 - 1. Remove defective lining down to bare steel by chipping, making sure care is taken to prevent further lining damage. Ends of lining where defective lining is removed are to be left square and uniform, not feathered.
 - 2. Clean bare steel with wire brush to remove loose or other foreign matter.
 - 3. Remove existing wire reinforcement and replace. Overlap new reinforcement to existing reinforcement by 1/2 inch. Secure reinforcement, against wall of pipe, at frequent intervals, by tack welding to pipe.
 - 4. Prepare cement mortar mixture. Mixture to compose of Portland Type II cement, sand, and water. Proportions of sand to cement not to exceed 3 parts sand to 1 part cement, by weight. Use only enough water to obtain proper placement characteristics. Set-up time before mixture is to be discarded is to be no longer than 1/2 hour. Non-shrink grout may also be used. Do not use combination of cement mortar and non-shrink grout within same repair.
 - 5. Apply WELD-CRETE, or approved equal, concrete bonding agent to bare steel and interface of existing lining. After bonding agent is applied to steel and lining, new mix must be applied within 10 minutes.
 - 6. Apply cement mortar to repair area 1/2 inch thick, then hand trowel to achieve smooth dense finish, making sure wire is not left exposed. To ensure

proper thickness while placing new mortar, check thickness with 1/2-inch-long wire gauge.

7. Curing: Place plastic sheeting over repair area; use tape to adhere plastic to area surrounding repair area. Let cure for 4 days, then remove plastic sheeting.

END OF SECTION

Section 02520

FIRE HYDRANTS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Fire hydrants.
- B. Adjustment of fire hydrants and gate valves.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment is on a unit price basis for each fire hydrant assembly, including 6-inch gate valve and box, installed regardless of barrel depth.
 - 2. Payment for fire hydrant branches (leads) is on linear foot basis for each branch installed. Separate pay items are used for open-cut and augured branches.
 - 3. Payment for salvaged fire hydrants is on unit price basis for each fire hydrant removed and returned to Authority's Maintenance Quadrant Stock yard.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AWWA C 502 – Standard for Dry Barrel fire Hydrants (Latest Edition).
- B. AWWA C 550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants
- C. SSPC SP2 - Hand Tool Cleaning
- D. SSPC SP3 - Power Tool Cleaning
- E. SSPC SP10 - Near-White Blast Cleaning

- F. SSPC SP11 - Power Tool Cleaning to Bare Metal
- G. SSPC 42 – Epoxy Polyamide/Polyamidoamine Primer, performance based
- H. SSPC 36 – Two-Component Weatherable Aliphatic Polyurethane Topcoat, performance based

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit name of hydrant manufacturer, type of bonnet paint, and engineering control drawing number for hydrant proposed for use.

PART 2 PRODUCTS

2.1 HYDRANTS

- A. Provide fire hydrants in conformance with AWWA C 502, Standard for Dry Barrel Fire Hydrants (Latest Edition). Hydrants are approved by the Authority for issuance of a Certificate of Responsibility. Only hydrants with current Certification of Responsibility will be allowed in Authority projects. Approved fire hydrants are listed under Authority's Approved Water Product List. See <https://edocs.publicworks.houstontx.gov/engineering-and-construction/approved-products-and-product-approval-committee/approved-water-products.html>
- B. The Engineer may, at any time prior to or during installation of hydrants, randomly select furnished hydrant for disassembly and laboratory inspection, at Authority expense, to verify compliance with Specifications. When hydrant is found to be non-compliant, replace, at Contractor's expense, hydrants, with hydrants that comply with Specifications.
- C. Provide lower hydrant barrel fabricated from Ductile Iron Pipe as single piece, connected to upper hydrant barrel by means of joint coupling that will provide three hundred sixty degree (360) rotation of upper barrel.

2.2 LEADS

- A. Branches (Leads): Conform to requirements of Section 02501 - Ductile Iron Pipe and Fittings, Section 02502 - Steel Pipe and Fittings, and Section 02506 - Polyvinyl Chloride Pipe.

2.3 HYDRANT PAINTING

- A. New hydrants and refurbished hydrants shall be shop coated as specified herein.
- B. Exterior Above Traffic Flange (Including Bolts & Nuts). Bolts and nuts (both above and below ground) shall conform to AWWA C-502 Section 4.11 and shall be stainless steel, cadmium plated, or zinc coated.
 - 1. Surface preparation to be in accordance with SSPC-SP 10 (NACE 2) near white blast cleaned surface.
 - 2. Coat with a liquid or powder epoxy primer and two part polyurethane or TGIC polyester top coat system with total dry film thickness (DFT) of not to exceed 20 mils as follows:
 - a. Prime Coat - Liquid or powder epoxy primer with a total dry film thickness (DFT) of 4-6 mils, OR cathodic epoxy electro-coat (e-coat) with a (DFT) of 0.5-1.0 mils.
 - b. Intermediate Coat – Intermediate coat not required.
 - c. Finish Coat - Two part polyurethane enamel to be in general conformance with SSPC Paint Specification No. 36 or TGIC polyester system, with a total dry film thickness (DFT) 1.5-3.0 mils. Install color coded finish coating of bonnet in field.
 - d. Bonnet Paint - Field apply finish coat of Silicone Alkyd Resin Enamel to be in general conformance with SSPC Paint Specification No. 21. Dry film thickness of 2 - 3 mils. Bonnet colors are to be as specified in Paragraph 3.01 to designate the appropriate size of water supply line.
 - 3. Colors - Primer: Manufacturer's standard color. Finish coat of hydrant body: Federal Standard Color #15187 (Blue) or equivalent. Bonnet and Connection caps: Finished coated white. Paint white band of finish coat two (2) inches in width on hydrant body approximately six inches (6") above and parallel to traffic flange.
- C. Field Maintenance Painting (Exterior Above Traffic Flange)
 - 1. Surface Preparation to be in accordance with SSPC - SP2, Hand Tool Cleaning, or SSPC - SP3, Power Tool Cleaning, depending on condition of existing paint and extent of corrosion. It is not necessary to remove tightly adhered mill scale, rust, and paint. Mill scale, rust and paint are considered tightly adherent when they cannot be removed with dull putty knife. In some severe cases where it is necessary to remove majority of existing paint, surface should be cleaned in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal.

2. When surface is cleaned to bare metal (SSPC - SP11), coat hydrant with three coat Alkyd/Silicone Alkyd system in accordance with Paragraph 2.03.B.2 as for new hydrants. When surface is cleaned to SSPC - SP2 or SSPC - SP3, coat hydrant with Silicone Alkyd Resin Enamel in general conformance with SSPC Paint Specification No. 21. Total dry film thickness of 3-6 mils. Field coating should be conducted in accordance to the individual coatings manufacturer's recommendations.
- D. Exterior Below Traffic Flange (including lower barrel extensions).
1. Surface preparation in accordance with SSPC- SP10 (NACE 2) Near White Blast Cleaned Surface.
 2. Primer: One or two coats of modified or equal polyamide epoxy primer, to be in general conformance with SSPC Paint Specification No. 42 or approved equal with a total dry film thickness (DFT) of 20 mils. Exterior below traffic flange should be the same color as the above traffic flange, i.e., blue. (Federal Standard Color #15187 (Blue) or equivalent.)
- E. Interior Surfaces Above and Below Water Line Valve (including lower barrel extensions)
1. Material used for internal coating of hydrant interior ferrous surfaces must be NSF certified as suitable for contact with potable water as required by Chapter 290, Rules and Regulations for Public Water Systems, Texas Commission on Environmental Quality.
 2. Coating shall be liquid or powder epoxy system in accordance with AWWA Standard C - 550 (latest revision). Coating may be applied in two or three coats, according to manufacturer's recommendations, for total dry film thickness not to exceed 20 mils.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Set fire hydrant plumb and brace at locations and grades as shown on Drawings. When barrel of hydrant passes through concrete slab, place 1-inch-thick piece of standard sidewalk expansion joint material around section of barrel passing through concrete.
- B. Locate nozzle center line minimum 18 inches above finish grade.

- C. Place 12-inch by 12-inch yellow indicators (plastic, sheet metal, plywood, or other material approved by Engineer) on pumper nozzles of new or relocated fire hydrants installed on new water lines not in service. Remove indicators after new water line is tested and approved by Engineer.
- D. Do not cover drain ports when placing concrete thrust block.
- E. Obtain Engineer's approval in writing prior to installation of hydrants which require changes in bury depth due to obstructions not shown on Drawings. Unit price adjustments will not be allowed for changes in water line flow line or fire hydrant barrel length caused by obstructions.
- F. Plug branch lines to valves and fire hydrants shown on Drawings to be removed. Deliver fire hydrants designated for salvage to nearest Utility Maintenance Quadrant Facility.
- G. Install branches (leads) in accordance with Section 02511 - Water Lines.
- H. Coating Requirements:
 - 1. Apply coatings in strict accordance with manufacturer's recommendations. No requirements of this specification shall cancel or supersede written directions and recommendations of specific manufacturer so as to jeopardize integrity of applied system.
 - 2. Furnish affidavit of compliance that coatings furnished complies with requirements of this specification and referenced standards, as applicable.
- I. Use following color code for field coating of hydrant bonnet to indicate size of water line supplying hydrant:

Supply Water Line Diameter (inches)	Bonnet Color
6	Yellow
8	White
12-20	Green
24 and larger	Orange

- J. Remove and dispose of unsuitable materials and debris in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02521

GATE VALVES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Gate valves.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. No separate payment will be made for gate valves 20 inches in diameter and smaller under this Section. Include payment in unit price for water lines.
2. Payment for gate valves 24 to 48 inches in diameter is on a unit price basis. Unit price includes cost of required box for gate valves.
3. Payment for 2-inch blow-off valve with box is on a unit price basis for each installation.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- B. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Casting.
- C. ASTM D 429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
- D. ASTM B 763 - Standard Specification for Copper Alloy Sand Casting for Valve Application.
- E. AWWA C 500 - Standard for Metal-Seated Gate Valves for Water Supply Service.

- F. AWWA C 509 - Standard for Resilient-Seated Gate Valves for Water Supply Service.
- G. AWWA C 515- Standard for Reduced Wall, Resilient- Seated Gate Valves for Water Supply Service.
- H. AWWA C 550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's product data for proposed valves for approval.
- C. Provide detailed drawings of gearing mechanism for 20-inch and larger gate valves.

1.5 QUALITY CONTROL

- A. Submit manufacturer's affidavit that gate valves are manufactured in the United States and conform to stated requirements of AWWA C 500, AWWA C 509, AWWA C 515, and this Section, and that they have been satisfactorily tested in the United States in accordance with AWWA C 500, AWWA C 509, and AWWA C 515.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Gate Valves: AWWA C 500, AWWA C 509, AWWA C 515 and additional requirements of this Section. Direct bury valves and those in subsurface vaults open clockwise; aboveground and plant valves open counterclockwise.
- B. If type of valve is not indicated on Drawings, use gate valves as line valves for sizes 20-inches and smaller. When type of valve is indicated, no substitute is allowed.
- C. Gate Valves 1-1/2 inches in Diameter and Smaller: 125 psig; bronze; rising-stem; single- wedge; disc type; screwed ends.
- D. Coatings for Gate Valves 2 inches and larger: AWWA C 550 non-toxic, imparts no taste to water, functions as physical, chemical, and electrical barrier between base metal and surroundings, minimum 8-mil-thick, fusion-bonded epoxy. Prior to assembly of valve, apply protective coating to interior and exterior surfaces of

body.

- E. Gate Valves 2 inches in diameter: Iron body, double disc or resilient-seated, non-rising stem, 150-pound test, 2-inch square nut operating clockwise to open.
- F. Gate Valves 3 inches to 12 inches in diameter: Non-directional, standard-wall resilient seated (AWWA C 509), parallel seat double disc (AWWA C 500), or reduced-wall resilient

seated gate valves (AWWA C 515), 200 psig pressure rating, bronze mounting, push-on bell ends with rubber joint rings, and nut-operated unless otherwise specified. Provide approved standard-wall resilient seated valves. Provide approved reduced-wall resilient seated valves. Provide approved double disc valves. Comply with following requirements unless otherwise specified in Drawings:

1. Design: Fully encapsulated rubber wedge or rubber seat ring mechanically attached with minimum 304 stainless-steel fasteners or screws; threaded connection isolated from water by compressed rubber around opening.
2. Body: Cast or ductile iron, flange bonnet and stuffing box together with ASTM A 307 Grade B bolts. Manufacturer's initials, pressure rating, and year manufactured shall be cast in body.
3. Bronze: Valve components in waterway to contain not more than 15 percent zinc and not more than 2 percent aluminum.
4. Stems: ASTM B 763 bronze, alloy number-995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.
5. O-rings: For AWWA C 500, Section 3.12.2. For AWWA C 509, Sections 2.2.6 and 4.8.2. For AWWA C 515, Section 4.2.2.5.
6. Stem Seals Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.
7. Stem Nut: Independent or integrally cast of ASTM B 62 bronze.
8. Resilient Wedge: Molded, synthetic rubber, vulcanized and bonded to cast or ductile iron wedge or attached with 304 stainless steel screws tested to meet or exceed ASTM D 429 Method B; seat against epoxy-coated surface in valve body.
9. Bolts: AWWA C 500 Section 3.4, AWWA C 509 Section 4.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.

- G. Gate valves 14 inch and larger in Diameter: AWWA C 500; parallel seat double disc gate valves; push-on bell ends with rubber rings and nut-operated unless otherwise specified. Provide approved double disc valves with 150 psig pressure rating. Comply with following requirements unless otherwise specified on Drawings:
1. Body: Cast iron or ductile iron; flange together bonnet and stuffing box with ASTM A 307 Grade B bolts. Cast following into valve body manufacturer's initials, pressure rating, and year manufactured. When horizontally mounted, equip valves greater in diameter than 12 inches with rollers, tracks, and scrapers.
 2. O rings: For AWWA C 500, Section 3.12.2. For AWWA C 515, Section 4.2.2.5.
 3. Stems: ASTM B 763 bronze, alloy number-995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.
 4. Stem Nut: Machined from ASTM B 62 bronze rod with integral forged thrust collar machined to size; non-rising.
 5. Stem Seals: Consist of three O-rings, two above and one below thrust collar with anti- friction washer located above thrust collar for operating torque.
 6. Bolts: AWWA C 500 Section 3.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.
 7. Discs: Cast iron with bronze disc rings securely penned into machined dovetailed grooves.
 8. Wedging Device: Solid bronze or cast-iron, bronze-mounted wedges. Thin plates or shapes integrally cast into cast-iron surfaces are acceptable. Other moving surfaces integral to wedging action shall be bronze monel or nickel alloy-to-iron.
 9. Provide bypass for double-disc valves (AWWA C500).
 10. Bronze Mounting: Built as integral unit mounted over, or supported on, cast-iron base and of sufficient dimensions to be structurally sound and adequate for imposed forces.
 11. Gear Cases: Cast iron; furnished on 18-inch and larger valves and of extended type with steel side plates, lubricated, gear case enclosed with oil

seal or O-rings at shaft openings.

12. Stuffing Boxes: Located on top of bonnet and outside gear case.
- H. Gate valves 14 inches to 48 inches: Provide AWWA C 515; reduced-wall, resilient seated gate valves with 250 psig pressure rating. Furnish with spur or bevel gearing.
1. Mount valves horizontally if proper ground clearance cannot be achieved by normal vertical installation. For horizontally mounted gate valves, provide bevel operation gear mounted vertically for above ground operation.
 2. Use valve body, bonnet, wedge, and operator nut constructed of ductile iron. Fully encapsulate exterior of ductile iron wedge with rubber.
 3. Ensure wedge is symmetrical and seals equally well with flow in either direction.
 4. Provide ductile iron operator nut with four flats at stem connection to apply even input torque to the stem.
 5. Bolts: AWWA C515, Section 4.4.4, Stainless Steel; cadmium plated or zinc coated.
 6. Provide high strength bronze stem and nut.
 7. O-rings: AWWA C515, Section 4.2.2.5, pressure O-rings as gaskets.
 8. Provide stem sealed by three O-rings. Top two O-rings are to be replaceable with valve fully open at full rated working pressure.
 9. Provide thrust washers to the thrust collar for easy valve operation.
- I. Gate Valves Extension Stem: When shown on Drawings, provide non-rising, extension stem having coupling sufficient to attach securely to operating nut of valve. Upper end of extension stem shall terminate in square wrench nut no deeper than 4 feet from finished grade or as shown on Drawings. Support extension stem with an arm attached to wall of manhole or structure that loosely holds extension stem and allows rotation in the axial direction only.
- J. Gate Valves in Factory Mutual (Fire Service) Type Meter Installations: Conform to provisions of this specification; outside screw and yoke valves; carry label of Underwriters' Laboratories, Inc.; flanged, Class 125; clockwise to close.

- K. Gate Valves for Tapping Steel Pipe: Provide double disc gate valve. Resilient wedge gate valve shall only be installed in a vertical position.
- L. Provide flanged joints when valve is connected to steel or PCCP.
- M. Key valve stem into the operator nut.
- N. Do not exceed 600 ft-lbs of torque on operator nut on gate valve.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Earthwork. Conform to applicable provisions of Section 02317 - Excavation and Backfilling for Utilities.
- B. Operation. Do not use valves for throttling without prior approval of manufacturer.

3.2 SETTING VALVES AND VALVE BOXES

- A. Remove foreign matter from within valves prior to installation. Inspect valves in open and closed positions to verify that parts are in satisfactory working condition.
- B. Install valves and valve boxes where shown on Drawings. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet. Install valves completely closed when placed in water line.
- C. For pipe section of each riser, use only 6 inch, ductile iron Class 51, or DR18 PVC pipe cut to proper length. Riser must be installed to allow complete access for operation of valve. Assemble and brace box in vertical position as indicated on Drawings.

3.3 DISINFECTION AND TESTING

- A. Assist Engineer with disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Water Lines and test as required by Section 02515 - Hydrostatic Testing of Pipelines.
- B. Double-Disc Gate Valves: Apply hydrostatic test pressure equal to twice rated working pressure of valve between discs. Valve shall show no leakage through metal, flanged joints, or stem seals. Test at rated working pressure, applied between discs. Valve shall show no leakage through metal, flanged joints, or stem seals. Do not exceed leakage rate of 1 oz/hr/inch of nominal valve size.

- C. Solid-Wedge Gate Valves: Apply hydrostatic pressure equal to twice rated working pressure of valve with both ends bulkheaded and gate open. Valve shall show no leakage through metal, flanged joints, or stem seals. Test at rated working pressure, applied through bulkheads alternately to each side of closed gate with opposite side open for inspection. Valve shall show no leakage through metal, flanged joints, or stem-seals. Do not exceed leakage rate of 1oz/hr/inch of nominal valve size.
- D. Repair or replace valves which exceed leakage rate.

3.4 PAINTING OF VALVES

- A. Paint valves in vaults, stations, and above ground with approved paint.

END OF SECTION

Section 02522

BUTTERFLY VALVES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Butterfly valves.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for butterfly valves with operator manhole or valve box is on a unit price basis for each. Payment includes actuator, valve box or manhole (where shown), foundation and appurtenances necessary for complete installation and full operation of valve.
 - 2. For butterfly valves with vault, valve and vault will be paid separately. Butterfly Valve will be paid on a unit price basis for each and includes hardware, actuator, testing and installation. Vault will be paid on a lump sum basis, and includes all materials, equipment, and appurtenances necessary for complete vault structure, foundation and supports as shown on Drawings.
 - 3. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- B. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- C. ASTM A 536 – Standard Specification for Ductile Iron Castings.
- D. ASTM A 564 – Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
- E. AWWA C 504 - Standard for Rubber-Seated Butterfly Valves.

- F. AWWA C 516 – Large-Diameter Rubber-Seated Butterfly Valves, Sizes 78 in. (2,000 mm) and Larger.
- G. NSF/ANSI 61 – Drinking Water System Components – Health Effects.
- H. AWWA C 550 - Standard for Protective Interior Coatings for Valves and Hydrants.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's product data for proposed valves and actuators for approval.
- C. Submit Proof-of-Design and hydrostatic testing procedures in accordance with AWWA C504 or C516.
- D. As part of initial review, submit manufacturer's affidavits certifying the following:
 - 1. Compliance with specifications for valves and actuators.
 - 2. Butterfly valves manufactured in the United States.
 - 3. Butterfly valves conform to applicable requirements of AWWA C504 or C516.
- E. Butterfly valves have been satisfactorily tested in the United States in accordance with AWWA C504 or AWWA C516 using test pressure of 150 psi in both directions.
- F. At time of delivery, submit manufacturer's affidavits of compliance certifying the following:
 - 1. Coatings for interior surfaces of valves conform to applicable requirements of AWWA C550. Submit results of holiday test and thickness measurements of coatings.
 - 2. Valves were manufactured in accordance with AWWA C504 or C516.
- G. At time of delivery, furnish certified drawings and material test records by manufacturer. Furnish certified copies of test reports for review.
- H. Submit data indicating maximum torque required to open valve, maximum torsional strength of shaft and torque output of actuator.
- I. Provide submittal information electronically in Adobe portable document format (*.PDF).

- J. Include number of turns to operate valves to fully open/closed.
- K. For 30-inch and larger diameters, submit procedures for complete seat replacement in the field.

1.5 QUALITY CONTROL

- A. Perform valve leakage tests in both directions at 150 psi in factory and field. Hydrostatic field tests of 150 psi shall be made against dished head plug or similar arrangement.
- B. When proof of design tests are performed on valve delivered to job site, replace disc, bushing, shaft and seals with new unused items, and test and certify as described above.
- C. Hydrostatic Testing by Manufacturer:
 - 1. Hydrostatic testing to be witnessed by Engineer prior to shipment of valves. Provide minimum 4 weeks notice to Engineer to schedule witness testing. When possible, maximize number of valves to be tested during a plant visit; no more than two visits will be allowed per project to witness test valves, unless otherwise approved by Engineer. Authority will pay expenses for each visit up to total of two visits incurred by Engineer to witness testing of each grouping of valve(s) per project. Expenses for subsequent or extended visits by Engineer for defective valves, improper scheduling or valve failures are to be paid by Contractor. Witness of hydrostatic testing by Engineer will only be in regard to compliance with this specification and will not constitute approval by Engineer nor relieve Contractor of obligations to comply with contract documents.
 - 2. Document serial number on valve at time of testing and reflect in certified test records furnished to Engineer. Identification plate must be permanently affixed to valve and actuator prior to hydrostatic testing.
 - 3. Hydrostatic testing to conform to AWWA C504 or C516 except as modified below:
 - a. Install actuator prior to hydrostatic testing. Test actuator to verify actual number of turns match manufacturer's published number of turns. Verify valve stops are in correct positions.
 - b. Fully open and close valve prior to performing shell test and prior to each leakage test.
 - c. Perform shell test first.

- d. When tested with water, adequately dry seat and disc.
 - e. When tested with air, fill top of valve with water to aid in viewing possible leakage.
 - f. Pressure Gauges: Calibrated within past 12 months; 0-500 psi range in increments of 5 psi; present calibration certificates prior to hydrostatic testing.
 - g. If seat adjustment is required during hydrostatic testing, perform valve leakage test again in both directions. Once seat adjustment is made, fully open and fully close valve three (3) times, and repeat leakage test.
4. Field Testing:
- a. When valve arrives at the job site, Contractor is to operate valve fully open and closed twice in presence of Engineer. Document number of turns to open and close each time.
 - b. Install operator nut plum.
 - c. After valve is installed, repeat the operation test and document number of turns in presence of Engineer.
 - d. Manufacturer's representative must be present to witness the operation test again at the substantial walk thru. Verify valve operate fully open/closed twice at the appropriate number of turns.

PART 2 PRODUCTS

2.1 VALVES AND ACTUATORS

- A. Butterfly Valves and Actuators: Provide approved butterfly valves and actuators. Conform to AWWA C504 for 72-inch and smaller diameters. Conform to AWWA C516 for 78-inch and larger diameters. Compliance with NSF 61 is required for all parts in contact with finished water.
- B. If type of valve is not indicated on Drawings, use butterfly valves for line valve sizes 30-inches and larger. When type of valve is specified on Drawings, no substitute will be allowed, unless otherwise approved by Engineer.
- C. Butterfly valves shall be short-body, flanged design and installed at locations as shown on Drawings.

- D. Direct-bury valves and valves in subsurface vaults shall open clockwise. Above-ground and plant valves shall open counterclockwise.
- E. Provide flanged joints when valve is connected to steel or PCCP. Provide ASTM A193 Grade B7 high strength steel stud bolts with ASTM A194 heavy hex nuts. Use cadmium-plated steel hardware underground. Mark bolts and nuts per ASTM. Refer to flange bolting requirements in Section 02511 – Water Lines.
- F. Butterfly Valves and Actuators:
 - 1. Provide valves from approved manufacturer ⁽¹⁾. Provide all valves for single project, from same manufacturer, modified as necessary for seat replacement in field for Authority.
 - 2. Provide manual actuators for single project from same manufacturer.
 - 3. Shaft connecting actuator to valve body must be fully enclosed. Bonnet and extension to be fully enclosed and watertight.

2.2 VALVE CONSTRUCTION

- A. Valves:
 - 1. 72-inches and smaller diameters: AWWA C504, Class 150B. Body: Cast Iron, ASTM A 126, Class B, or Ductile Iron. Flanges: ASME B16.1, Class 125.
 - 2. 78-inches and larger diameters: AWWA C516, Class 150B. Body: ASTM A536 Grade 65-45-12. Flanges: ASME B16.1, Class 125 for up to 96-inch, AWWA C207, Class D with bolt holes ¼-inch larger than nominal bolt diameter for larger than 96-inch diameters.
- B. Discs: ASTM A536 Grade 65-45-12 Ductile Iron.
- C. Seats:
 - 1. 20-inches and smaller diameters: Rubber body seats shall be EPDM-P (Ethylene Propylene Diene Monomer), and may be simultaneously bonded and vulcanized to body of valve or mechanically secured using stainless steel retainer ring and bolts.
 - 2. 24-inches to 48-inches in diameter: EPDM-P (Ethylene Propylene Diene Monomer), and may be applied to the disc or body. Retain seat in position by mechanical means. Do not rely solely on adhesive properties of epoxy

- or similar bonding agent to attach seat to body. Mating surfaces for seats: Type 304 or 316 stainless steel, and secured to disc by mechanical means. Sprayed-on or plated mating surfaces not allowed. Seat must be adjustable and replaceable in field for valves greater than 30-inches in diameter with no special tools.
3. 54-inches and larger diameter: EPDM-P (Ethylene Propylene Diene Monomer), and may be applied to the disc or body. Mechanically secure seat to disc or body using stainless steel retainer ring and bolts. Do not solely rely on adhesive properties of epoxy or similar bonding agent to attach seat to body. When seat is on disc, retain seat in position by shoulders located on both disc and stainless steel retaining ring. Mating surfaces for seats: Type 304 or 316 stainless steel, and secured to disc by mechanical means. Sprayed-on or plated mating surfaces not allowed. Seat must be adjustable and replaceable in field with no special tools.
- D. Coat interior wetted ferrous surfaces of valve, including disc, with epoxy or fusion bonded epoxy suitable for potable water conditions. Epoxy, surface preparation, and epoxy application in accordance with AWWA C550 and coating manufacturer's recommendations. Provide minimum dry film thickness of 8 mils for epoxy coating or minimum DFT of 16 mils for fusion bonded epoxy. Coatings shall be holiday tested and measured for thickness.
- E. Valve shaft and keys: 24-inches in diameter and greater require a minimum of two (2) taper pins used for attaching valve shaft to valve disc. Use of torque plug for purposes of attaching valve shaft is not permitted. Shaft bearings: stainless steel, bronze, nylon or Teflon (supported by fiberglass mat or backing material with proven record of preventing Teflon flow under load) in accordance with AWWA C504 or C516. Sinter stainless steel bearing material. Shaft material:
1. 72-inches and smaller: Type 304 stainless steel for treated (potable) water applications. Type 316 stainless steel for raw water applications.
 2. 78-inches and larger: ASTM A564, Type 630 (17-4 PH), Stainless Steel Condition 1150.
 3. Design shaft to withstand 3 times the amount of torque necessary to seat the valve while operating from the fully open to the fully closed position. Flow direction used in torque calculations shall be as shown on Drawings, or that which results in maximum torque requirements if bi-directional flow is shown or if direction is not identified on Drawings.
- F. Packing: Self adjusting and wear compensating, full or split ring V-type.
- G. Retaining Hardware for Seats: Type 304 or 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securely with locktite blue 242,

or other approved equal, to prevent loosening by vibration or cavitational effects.

- H. Valve disc shall seat in position at 90 degrees to pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow, except where shown otherwise on Drawings.

For valves utilizing retaining rings, tighten bolts to a uniform torque. Measure torque prior to testing valve.

2.3 VALVE ACTUATOR CONSTRUCTION

- A. Provide actuators for valves with size based on line velocity of 16 feet per second and uni-directional service, unless bi-directional service is shown on Drawings. Provide geared manual actuators unless otherwise shown on Drawings. Provide fully enclosed and traveling-nut type, rack-and-pinion type, or worm-gear type for valves 24-inches and smaller. For 30-inches and larger, provide worm-gear or traveling-nut type.
- B. Provide actuator designed for installation with valve shaft horizontal unless otherwise indicated on Drawings.
- C. Provide bonnet extensions, as required, between valve body and actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements, even when fully submerged.
- D. Provide oil-tight and watertight actuator housings for valves, specifically designed for submerged service, and factory packed with suitable grease.
- E. Install valve position indicator on each actuator housing located above ground or in valve vaults. Valves shall be equipped with 2-inch actuator nut only.
- F. Indicate direction of opening of valve on exposed visible part of assembly and cast direction of open on 2-inch nut on top of valve operator extension. Paint 2-inch actuator nut and extension shaft black when counterclockwise open and red when clockwise to open.
- G. Design worm-gear actuators to be self-locking and designed to transmit twice the required actuator torque without damage to faces of gear teeth or contact faces of screw or nut. Flow direction used in torque calculations shall be as shown on the Drawings, or that which results in maximum torque requirements if bi-directional flow is shown or if direction is not identified on Drawings.
- H. Actuators shall be capable of withstanding minimum 450 foot-pounds of torque against the stops without damage to any parts of the actuator or valve.

2.4 VALVE SERVICE MANHOLES

- A. Unless the valve is placed in a vault or otherwise shown on the Drawings, provide manholes to dimensions shown on Drawings conforming to requirements of Section 02082 - Precast Concrete Manholes.

PART 3 EXECUTION

3.1 EARTHWORK

- A. Conform to applicable provisions of Section 02317 - Excavation and Backfill for Utilities.

3.2 SETTING VALVES AND VALVE BOXES

- A. Prior to hydrostatic testing of water line and valve:
 - 1. Test valve by opening and closing valve a minimum of two times to verify valve seats properly.
 - 2. Verify number of turns from fully open to fully closed position is same as identified in manufacturer's submittal.
 - 3. Adjust valve as required if number of turns do not match.
 - 4. Remove foreign matter from within valves.
- B. Install valves in accordance with manufacturer's recommendations. Install valves where shown on Drawings or as located by Project Manager.
- C. Avoid disturbing or overstressing valve body when installing valves. Perform field adjustment of valves under pressure to ensure shutoff occurs in number of rotations as described in valves operation and maintenance manual.
- D. Submit certification that large diameter valve was installed, adjusted, and exercised in accordance with manufacturer's instructions. Manufacturer's certification shall state that all performance characteristics of large diameter valves, as installed, have been met. Adjustments made to valve, for any reason, must be made by manufacturer's representative.

3.3 DISINFECTION AND HYDROSTATIC TESTING

- A. Assist Engineer with disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Water Lines and test as required by Section 02515 - Hydrostatic Testing of Pipelines. Do not use valves for throttling flow without prior

approval of manufacturer.

3.4 COATING OF PIPING

- A. Coat valves located in vaults, stations, and above ground using approved paint. Coating shall be 6-12 mils thick, but no more than 12 mils. Apply coating in accordance with manufacturer's recommendations.

END OF SECTION

Section 02524

AIR VALVES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This specification covers air valves in Authority owned and operated facilities.
 - 1. Combination Air Valves (CAV)
 - 2. Combination Air Valves with Bias (CAVB)
- B. Refer to City of Houston Standard Specification Section 02524 – AIR RELEASE AND VAUUM RELIEF VALVES for air valves required on facilities not owned or operated by the Authority required for utility relocations.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for air valves on Authority owned and operated water lines is on unit price basis for each valve installed.
 - 2. Payment includes manhole or vault (when required), fittings, vent piping and bollard(s) and appurtenances necessary for complete installation of valve.
 - 3. Payment for valve assembly on aerial crossing includes fittings, anti-vandalism protection, freeze protection, vent piping and appurtenances necessary for complete installation of valve.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates

- B. ANSI/AWWA C512 - Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
- C. AWWA C228 – Stainless-Steel Pipe Flanges for Water Service (2-Inch Through 72-Inch)
- D. AWWA C550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants
- E. NSF/ANSI 61 - Drinking Water System Components – Health Effects
- F. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
- G. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
- H. ASTM A 313 - Standard Specification for Stainless Steel Spring Wire.
- I. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's product data for proposed valves for approval.

1.5 QUALITY CONTROL

- A. Submit manufacturer's affidavit that air valves conform to stated requirements of AWWA C512 and this Section, and that they have been satisfactorily tested in the United States in accordance with AWWA C512. Certified Test report are to be submitted at least seven (7) days prior to valve shipment.
- B. Valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects.
- C. Coatings used on valve interiors and exterior for potable water service shall be NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550.
- D. The manufacturer shall demonstrate a minimum of five (5) years' experience in the manufacture of air valves. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and

maintenance manuals.

- E. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

PART 2 P R O D U C T S

2.1 ACCEPTABLE MANUFACTURERS

- A. RF Valves, Inc. – Vent-O-Mat, Hanover, MD, USA
- B. International Valve Marketing – Vent-Tech, Sugar Grove, IL, USA
- C. Or Engineer Approved Substitution

2.2 DESCRIPTION & SERVICE

- A. Combination Air Valves (CAV) and Combination Air Valves with Bias (CAVB): CAVs and CAVBs are designed to vent large quantities of air automatically during a liquid piping system filling and to admit large quantities of air automatically when the pressure in the liquid piping system drops below atmospheric pressure. CAVBs slow the approach of water that may create high pressure spikes when the valve suddenly closes and limit internal pressure rise to 1.5 times the working pressure of the valve by controlling the venting of air. In addition, CAVs and CAVBs automatically release small pockets of accumulated air and gases from a liquid piping system while the system operates at a pressure exceeding atmospheric pressure.

2.3 DESIGN & MATERIALS

- A. General:
 - 1. Each air valve shall have a 304 stainless steel, 316 stainless steel or ductile iron body and stainless steel trim. The valve body shall be tubular body constructed to provide an unobstructed circular space between the floats and inner valve body wall.
 - 2. Valve outlet shall be threaded or flanged for connection to vent piping for treated water systems.
 - 3. Valve and flange rating shall equal or exceed the maximum water line test pressure.

4. Floats shall be Ultra High Molecular Weight or High Density Polyethylene with EPDM O-Ring Seals.
- A. Combination Air Valves (CAV): Valves shall be single body design capable of exhausting large amounts of air automatically and admitting large quantities of air automatically when the system pressure drops below atmospheric. In addition, the design shall automatically release small pockets of accumulated air while the system is pressurized and in operation.
 1. Combination air valves shall be able to automatically exhaust and admit air without use of levers, pins, springs, hinges, or ball type floats, while the system operates at normal pressure.
 2. Combination air valves shall be heavy-duty, single-chamber air and vacuum valves with disc floats. Floats shall include discs drilled with the small and large orifices, and an anti-surge float. Internal clearances around the floats shall be equal to the inlet/outlet area. The anti-surge float should be normally opened and have drilled orifices to throttle water flow.
 3. Valve shall have ANSI Class 125 flange connections.
 4. Valve shall be adaptable for applications where air exhaust must be restricted and or regulated.
 - B. Combination Air Valves with Bias (CAVB): Valves shall be single body design capable of exhausting air automatically in a controlled manor through an “anti-shock” orifice and admitting large quantities of air automatically when the system pressure drops below atmospheric. In addition, the design shall automatically release small pockets of accumulated air while the system is pressurized and in operation. CAVB valves shall not require vacuum greater than 0.75 psig to open fully.
 - C. Manholes: As shown on Drawings confirming to requirements of Section 02082 – Precast Concrete Manholes.

PART 3 EXECUTION

3.1 EARTHWORK

- A. Conform to applicable provisions of Section 02317 - Excavation and Backfill for Utilities.

3.2 SETTING VALVES IN MANHOLES AND VAULTS

- A. If required by Engineer, provide services of technical representative of valve manufacturer available on site during installation of valves.
- B. Prior to installing valves, remove foreign matter from within valves. Inspect valves in open and closed position to verify that parts are in satisfactory working condition.
- C. Carefully handle and install valves vertically in such a manner as to prevent damage to any part of the valves. Installation shall be in accordance with the manufacturer's instructions. Provide nuts, bolts, and gaskets where applicable.
- D. Air valve and gate valve shall be braced adequately to withstand normal pipeline operation pressure and avoid undue stress on the pipe.
- E. Install valves and valve manholes and vaults where indicated on Drawings or by Engineer. Set manholes and vaults plumb and as detailed. Center manholes on valves. Compact cement-stabilized sand around each manhole and vault for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet. Provide above-ground vents for manholes and vaults as indicated on Drawings.

3.3 DISINFECTION AND TESTING

- A. Perform disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Waterlines and test as required by Section 02515 - Hydrostatic Testing of Pipelines.

3.4 PAINTING OF PIPING AND VALVES

- A. Paint piping and valves located in manholes, stations, and above ground using approved paint in accordance with Section 09901 – Protective Coatings.

END OF SECTION

Section 02525

TAPPING SLEEVES AND VALVES

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Tapping sleeves and valves for connections to existing water system.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment is on unit price basis for each tap installed.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
 - 3. For water lines 4-inches and greater, no payment will be made until coupon (cut out portion of pipe tapped) is delivered to the Authority.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
- B. ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- C. ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High- Pressure or High-Temperature Service
- D. AWWA C 110 - Standard for Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and other Liquids.
- E. AWWA C 200 - Standard for Steel Water Pipe - 6 in. and Larger.
- F. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in.

- G. AWWA C 500 - Standard for Metal Seated Gate Valves, for Water Supply Service.
- H. AWWA C 223 - Fabricated Steel and Stainless Steel Tapping Sleeves.
- I. OSHA 29 CFR 1926.1101 – Asbestos.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit results of tapping sleeves NPT test opening.
- C. Submit manufacturer's affidavit as required in Section 02521 - Gate Valves.
- D. For tapping fiberglass reinforced pipe (FRP), submit tapping procedures in accordance with FRP manufacturer's recommendations.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Ship steel sleeves in wooden crates that provide protection from damage to epoxy coating during transport and storage.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Tapping Sleeves:
 - 1. Tapping Sleeve Bodies: AWWA C 110 cast or ductile iron or AWWA C 200 carbon steel in two sections to be bolted together with high-strength, corrosion-resistant, low-alloy steel bolts with mechanical joint ends.
 - 2. Branch Outlet of Tapping Sleeve:
 - a. Flanged, machined recess, AWWA C 207, Class D, ANSI 150 pound drilling.
 - b. Gasket: Affixed around recess of tap opening to prevent rolling or binding during installation.
 - 3. Use cast iron split sleeve where fire service from 6-inch water line is approved.
 - 4. For tapping Fiberglass Reinforced Pipe (FRP), provide stainless steel tapping sleeves. Do not use cast iron or ductile iron tapping sleeves.

Comply with FRP pipe manufacturer's recommendations for tapping procedures.

- B. Welded-steel tapping-sleeve bodies may be used in lieu of cast or ductile iron bodies for following sizes and with following restrictions:
1. Flange: AWWA C 207, Class D, ANSI 150 pound drilling.
 2. Gasket: Affixed around recess of tap opening to prevent rolling or binding during installation.
 3. Steel sleeves are restricted to use on pipe sizes 6 inches and larger.
 4. Body: Heavy, welded-steel construction; top half grooved to retain neoprene O-ring seal permanently against outside diameter of pipe.
 5. Bolts: AWWA C 500 Section 3.5; coated with 100 percent vinyl resin or corrosive resistant material.
 6. Steel Sleeves Finish: Fusion-bonded epoxy coated to minimum 12 mil thickness.
 7. Finished Epoxy Coat: Free of laminations and blisters; and remain pliant and resistant to impact with non-peel finish.
 8. Provide approved steel tapping sleeves
 9. Tapping Sleeves: Provide with 3/4-inch NPT test opening for testing prior to tapping. Provide 3/4-inch bronze plug for opening.
 10. Do not use steel sleeves for taps greater than 75 percent of pipe diameter.
 11. Comply with AWWA C 223 - Fabricated Steel and Stainless Steel Tapping Sleeves.
- C. Stainless Steel tapping-sleeve bodies and flange may be used in lieu of cast or ductile iron bodies for following sizes and with following restrictions:
1. Flange: ASTM A240 Stainless Steel, Type 304, ANSI 150-pound drilling.
 2. Gasket: Full circumferential, affixed around recess of tap opening to prevent rolling or binding during installation, compounded for water and sewer service.
 3. Stainless Steel sleeves are restricted to use on pipe sizes 4 inches and larger.

4. Body: ASTM A240 Stainless Steel, Type 304.
 5. Bolts: ASTM A193 Stainless Steel, Type 304.
 6. Nuts: ASTM A194 Stainless Steel, Type 304
 7. Branch Outlet: Heavy Stainless Steel Pipe
 8. Provide approved stainless steel tapping sleeves.
 9. Do not use stainless steel sleeves for taps greater than 75 percent of pipe diameter.
 10. Comply with AWWA C 223 - Fabricated Steel and Stainless Steel Tapping Sleeves.
- D. Tapping Valves: Meet requirements of Section 02521 - Gate Valves with following exceptions:
1. Inlet Flanges:
 - a. AWWA C 110; Class 125.
 - b. AWWA C 110; Class 150 and higher: Minimum 8-hole flange.
 2. Outlet: Standard mechanical or push-on joint to fit any standard tapping machine.
 3. Valve Seat Opening: Accommodate full-size shell cutter for nominal size tap without contact with valve body; double disc.
- E. Valve Boxes: Standard Type "A" valve boxes conforming to requirements of Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

PART 3 EXECUTION

3.1 APPLICATION

- A. Install tapping sleeves and valves at locations and of sizes shown on Drawings, maintain 5 feet spacing from edge of tapping sleeve from any other tap or fitting. Install sleeve so valve is in horizontally level position unless otherwise indicated on Drawings.
- B. Clean tapping sleeve, tapping valve, and pipe prior to installation and in accordance

with manufacturer's instructions.

- C. Hydrostatically test installed tapping sleeve to 150 psig for minimum of 15 minutes. Inspect sleeve for leaks, and remedy leaks prior to tapping operation.
- D. When tapping concrete pressure pipe, size on size, use shell cutter one standard size smaller than water line being tapped.
- E. Do not use Large End Bell (LEB) increasers with next size tap unless existing pipe is asbestos- cement.

3.2 INSTALLATION

- A. Verify outside diameter of pipe to be tapped prior to ordering sleeve.
- B. Verify clearance of 5 feet to maintain spacing.
- C. Tighten bolts in proper sequence so that undue stress is not placed on pipe. For installation of tapping sleeves on FRP, comply with pipe manufacturer's recommendations for bolt torque values.
- D. Align tapping valve properly and attach to tapping sleeve. Insert insulation sleeves into flange holes of tapping valve and pipe. Make insertions of sleeves on pipe side of tapping valve. Do not damage insulation sleeves during bolt tightening process.
- E. Make tap with sharp, shell cutter:
 - 1. For 12-inch and smaller tap, use minimum cutter diameter one-half inch less than nominal tap size.
 - 2. For 16-inch and larger tap, use manufacturer's recommended cutter diameter.
 - 3. For tapping FRP pipe, comply with pipe manufacturer's recommendations for forward feed rate.
- F. Withdraw coupon and flush cuttings from newly-made tap.
- G. Wrap:
 - 1. For 12-inch and smaller tap, wrap completed tapping sleeve and valve in accordance with Section 02528 - Polyethylene Wrap.
 - 2. For 16-inch and larger tap, apply coal tar epoxy around completed tapping sleeve and valve. The coal tar epoxy shall be applied with minimum of two (2) coats. Each coat of coal tar epoxy shall have minimum dry film thickness of 16 mils.

- H. Place concrete thrust block behind tapping sleeve (not over tapping sleeve and valve).
- I. Request inspection of installation prior to backfilling.
- J. Backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.

3.3 **ADDITIONAL REQUIREMENTS FOR TAPPING ASBESTOS-CEMENT (AC) PIPE**

- A. Notify Engineer when AC pipe is encountered.
- B. Refer to Section 02221 – Removing Existing Pavements and Structures for crew training, safety precautions, and AC pipe removal requirements.
- C. Protocol:
 - 1. Mechanically excavate to no more than 6 in. of AC pipe. Carefully uncover the remainder of pipe by hand or with shovel.
 - 2. Keep pipe adequately wet before and during work.
 - 3. Locate tap a minimum of 2 ft. away from existing AC collar.
 - 4. Use of power tools is prohibited.
 - 5. Remove waste AC pipe coupon.

END OF SECTION

Section 02526

WATER METERS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Water meters, submeters, and fire service meters.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices

1. Measurement for water meters is on unit price basis for installation of each meter type and size.
2. Payment includes vault, piping and appurtenances necessary for complete installation of meter.
3. Measurement for relocating and reinstalling meter with new box is on unit price basis for each meter relocated and reinstalled.
4. No separate payment for adjustment of meter or meter box unless otherwise shown in Drawings.
5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work is in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASME B 16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
- B. AWWA C 510 - Standard for Double Check Valve Backflow - Prevention Assembly.
- C. AWWA C 700 - Standard for Cold-Water Meters - Displacement Type.
- D. AWWA C 701 - Standard for Cold-Water Meters - Turbine Type for Customer Service.
- E. AWWA C 702 - Standard for Cold-Water Meters - Compound Type.

- F. AWWA C 703 - Standard for Cold-Water Meters - Fire Service Type.
- G. AWWA Manual M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
- H. NFPA 13D - Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes
- I. NFPA 13R -Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit written certification of calibration and test results.
- C. Submit manufacturer's certification that meters meet applicable requirements of this Specification Section.
- D. Submit accuracy registration test certification from manufacturer for each 3-inch through 10- inch diameter meter.

1.5 QUALITY CONTROL

- A. Submit manufacturer's warranty against defects in materials and workmanship for one year from date of Substantial Completion.
- B. Provide vendor's unconditional guarantee that performance of each meter meets applicable AWWA standards and AWWA Manual M6 as follows:
 - 1. Displacement type: 10 years from installation or register registration shown below, whichever comes first.

Size (inch)	Registration (million gallons)
5/8, 3/4	1.5
1	2.5
1-1/2	5.0
2	10.5

- 2. Turbine type: 1 year from date of installation.
- 3. Compound type: 1 year from date of installation.

4. Fire service type: 1 year from date of installation.

Operations of hermetically sealed register, 5/8-inch to 2-inch diameter, shall be unconditionally guaranteed for 15 years.

- C. Provide manufacturer's unconditional guarantee for each sealed register against leakage, fogging, discoloration and stoppage for 15 years from date of installation.
- D. Vendor may replace meters that become defective within guarantee period with meters that comply with this Specification. The Authority will return defective meters to vendor at expense. Meters repaired or replaced under this guarantee must meet accuracy limits for new meters upon receipt and accuracy limits for remaining period of initial guarantee.

1.6 EASEMENT REQUIREMENTS

- A. Install 2-inch and smaller water meters and shut-off valves (stop boxes) in right-of-way when possible. Otherwise, install in a minimum 5 feet by 5 feet separate water meter easement contiguous with public right-of-way.
- B. Install 3-inch to 6-inch water meters in a minimum of 10 feet by 20 feet separate water meter easement contiguous with public right-of-way.
- C. Install 8-inch and larger water meters in a minimum of 10-feet by 25-feet separate water meter easement contiguous with public right-of-way.
- D. Locate water meter easements contiguous with public right-of-way unless approved by the Engineer. Provide minimum fifteen feet wide access easement when not contiguous with public right-of-way.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide meters of type and size as indicated on Drawings, unless otherwise indicated.
- B. Provide bolted split casings. Main casings of meters and external fasteners: Copper alloy with minimum 75 percent copper for 5/8 inch to 2 inches, bronze or cast iron, hot-dipped galvanized or epoxy coating for 3 inches and larger.
- C. Straightening Vanes: Non-corrosive material compatible with case material.
- D. Intermediate gear train shall not come into contact with water and shall operate in suitable lubricant.

- E. Registers: Automatic Meter Reading (AMR) type that provides pulse, contact closure, piezo switch or encoder generated output signal, compatible with the Authority's radio and telephone AMR systems. Provide minimum 12-foot wire when permanently connected to register. Lens: impact resistant. Register box: tamper resistant by means of tamper screw or plug. Register: permanently sealed, straight-reading, center-sweep test hand, magnetic driven, U.S. gallons. Digits: 6, black in color, with lowest registering 3 digits (below 1,000-gallon registration) having contrasting digit and background color. Register capacity of meters: 9.99 million gallons for 5/8 inch to 2 inches and 999.999 million gallons for 3 inches and larger. For existing meter replacements coordinate with customer and water provider as appropriate.
- F. Connections: 5/8 inch to 1 inch: threads at each end; 1-1/2 to 2 inches: 2-bolt oval flanges each end; 3 inches and larger: flange at each end.
- G. Stamp manufacturer's meter serial number on outer case. Stamp manufacturer's meter serial number on outside of register lid when provided. Manufacturer's serial numbers shall be individual and not duplicated.
- H. Meters: Provide approved meters and equipment with AMR type register to connect to the Authority's AMR system. For existing meter replacements coordinate with customer and water provider as appropriate.
- I. Manufacturing Quality Control shall permit successful interchangeability from one meter to another of same size including registers, measuring chambers and units, discs or pistons as units, change gears, bolts, nuts, and washers without affecting accuracy of new meter.
- J. For water meter vaults provide:
 - 1. 1/4-inch steel or aluminum access door with stainless steel hinge pins. Door shall open to 90 degrees and automatically lock in that position.
 - 2. Comply with detail(s) on the drawings.

2.2 METER REQUIREMENTS AND APPLICATIONS

- A. Meter type and general requirements:
 - 1. All Authority meters must be compatible with the Authority's automated meter reading (AMR) System and /or automated metering infrastructure (AMI) system.
 - 2. Sizes 5/8-inch to 2-inch Meters: Displacement type excluding application exceptions notes in paragraph 2.2 A.3.
 - 3. Exceptions
 - a. Meter types for sizes 1-inch to 2-inch for NFPA 13-D and 13-R applications

require prior approval by the Authority. (Displacement meters are not allowed for these applications).

- b. For applications where constant flow is required, a 2-inch turbine type meter may be substituted.

B. Meter sizes 3-inch and above:

1. Turbines:

Processing plants
Manufacturing facilities
Lawn sprinkler systems
Effluent water in treatment plants
Booster (pump) stations
Level controlled tank-filling operations
Fire hydrants (transients)
Inter-systems sale or transfer Sewer credit/sub-meter

2. Compounds:

Multi-family dwellings
Motels and hotels
Hospitals
Schools
Restaurants
Office buildings
Dormitories, nursing homes, department stores, shopping malls, and other commercial establishments

3. Fire Rated Turbines:

Open systems feeding directly from a tank

4. Fire Rated Compounds:

Combination domestic and fire services
Open system not feeding directly from a tank

5. Electromagnetic Meters:

Inter-system sale or transfer
Raw water
Basement or inside structure installations
Contract water
Above ground applications in potential hazardous chemical environs

Meters larger than 10-inches

C. Meter size requirements for flow rates:

Meter flow range is dependent on amount of pressure and slightly varies with manufacture.

Flow Range	Max. Continuous Flow	Meter Size & Type
¼ - 25 GPM	15 GPM	5/8" Positive Displacement
¾ - 70 GPM	50 GPM	1" Positive Displacement
1 ¼ - 120 GPM	80 GPM	1 ½" Positive Displacement
1 ½ - 170 GPM	100 GPM	2" Positive Displacement
5 – 550 GPM	450 GPM	3" Turbine
15 – 1250 GPM	1000 GPM	4" Turbine
20 – 2500 GPM	2000 GPM	6" Turbine
30 – 4500 GPM	3500 GPM	8" Turbine
50 – 7000 GPM	5500 GPM	10" Turbine
½ - 450 GPM	350 GPM	3" Domestic Compound
¾ - 1250 GPM	1000 GPM	4" Domestic Compound
1 – 2000 GPM	1400 GPM	6" Domestic Compound
¾ - 1200 GPM	1200 GPM	4" Fire Compound
½ - 2500 GPM	2500 GPM	6" Fire Compound
2 – 4000 GPM	4000 GPM	8" Fire Compound
2 – 6500 GPM	6500 GPM	10" Fire Compound

D. Meter location preference hierarchy for 3" and larger applications:

1. Adjacent to Public ROW
2. Not adjacent to Public ROW with water line easement.
3. Parking garage
4. Mechanical room area of basement
5. Public ROW

NOTE: Above ground meter installations are required in potential hazardous chemical areas and for meters larger than 10".

Eligibility Requirements for Meter Easement Locations								
Meter Location	Meter Easement	Water line Easement	P.A.E.	A.D.A. Requirements	Electric and Phone service	Encroachment permit	Min. Utility Spacing	Special Meter Vault, or Meter Setup Requirements
Grade Level Easement Adjacent to ROW	YES	NO	NO	NO	NO	NO	NO	NO
Grade Level Easement Not Adjacent to ROW	YES	YES	NO	NO	NO	NO	NO	NO
Parking Garage	YES	**NO	YES	NO	YES	NO*	NO	YES
Mechanical Room in Basement	YES	**NO	NO	NO	YES	NO*	NO	YES
Public ROW	NO	NO	NO	YES	NO	YES	YES	YES
Above Ground Installations	YES	**NO	YES	NO	YES	NO	NO	YES

Acronym Definition:

P.A.E.- Permanent Access Easement.

A.D.A.- American's with Disabilities Act.

ROW- Right Of Way.

* Provided structure does not encroach ROW

** Provided meter is set adjacent to ROW

2.3 MATERIALS

A. Cold-Water Meters:

1. Displacement Type: AWWA C 700; sizes 5/8 inch up to and including 2 inches; oscillating disc or piston of magnetic drive type; bolted split-case design, with either being removable.
2. Turbine Type: AWWA C 701; Class II; sizes 1½ inches through 10 inches; flanged; straight-through measuring chamber; rotor construction: polypropylene or similar non-rubber material with specific gravity of approximately 1.0, equipped with near frictionless replaceable bearings in turbine working against rotor shaft positioned thrust bearing. Transient/Fire Hydrant Meter Inlet: Female fitting for attachment to hose nozzle with National Standard Fire hose thread. Outlet: 2-inch nipple with National Pipe Thread. Include restriction plate to limit flow through meter to 400 gpm at 65 psi. 1½ inches through 8 inches are to be furnished with test plugs in the outlet port of the meter for field testing.
3. Compound Type: AWWA C 702; sizes 2 inches through 6 inches. Measuring chambers: For use in continuous operation; separate units of copper alloy (minimum 84 percent copper) or approved polymer material, inert in corrosive potable water; with centering device for proper positioning. Measuring pistons: Non-pilot type with division plates of rubber covering vulcanized to stainless steel or other approved material of sufficient thickness to provide minimum piston oscillation noise. Measuring discs: Flat or conical type, one piece, mounted on monel or 316 stainless steel spindle. Measuring chamber strainer screen area: Twice area of main case inlet.
4. Fire-Service Type: sizes 4 inches through 10 inches; turbine-type, compound type, proportional type; AWWA C 703, with separate check valve conforming to AWWA C510. Determine size of fire meter by adding fire flow and domestic flow.

2.4 STRAINERS

- A. Displacement Potable Water Meters 5/8 inch through 2 inches: Self-straining by means of annular space between measuring chamber and external case or with strainer screens installed in meter. Provide rigid screens which fit snugly, are easy to remove, with effective straining area at least double that of main case inlet.
- B. Potable Water Meters 2-inch diameter and larger: Equip with separate external strainer with bronze body for diameters less than 8 inches. 8-inch diameter and larger may be cast iron, hot-dipped galvanized or epoxy coating. Strainers: Bolted to inlet side of meter, detachable from meter, easily removable lid. Strainer screen: Made of rounded cast bronze, stainless steel wire, having nominal screen size of 3-1/2 mesh-per-inch (U.S. Series) not less than 45 percent clear area.
- C. Provide separate approved external strainers (when required by meter manufacturer) approved for use in fire service metered connections by Underwriters Laboratories. Bodies: Cast iron or copper alloy. Ends: Flanged in accordance with ASME B 16.1, Class

125. Provide stainless steel basket. Strainers shall be detachable from meter.

2.5 CONNECTIONS AND FITTINGS

- A. Provide pipe for connections in accordance with Section 02501 - Ductile Iron Pipe and Fittings and Section 02506 - Polyvinyl Chloride Pipe. Use restrained joints and flanged joints only.
- B. Fittings:
 - 1. For meters 2 inches and smaller: Same type of fittings as Outlet End fittings for Curb Stop in accordance with Section 02512 - Water Tap and Service Line Installation.
 - 2. For meters 3 inches and larger: Restrained ductile iron; push-on bell joints or mechanical joint fittings between water line and meter vault; Class 125 flanged inside meter vaults; cement mortar lined and sealed.

2.6 LAYING LENGTHS

- A. Minimum laying lengths for meter and standard strainer shall be as shown on Drawings.

PART 3 EXECUTION

3.1 TAPPING AND METER SERVICE INSTALLATION

- A. Refer to Section 02525 - Tapping Sleeves and Valves for tapping requirements.
- B. Meter Service Line:
 - 1. Use pipe and fittings conforming to requirements of Section 02501 - Ductile Iron Pipe and Fittings, or Section 02506 - Polyvinyl Chloride Pipe.
 - 2. Limit pulling and deflecting of joints to limits recommended by manufacturer.
 - 3. Make vertical adjustments with offset bends where room will permit. Minimize number of bends as shown on detail drawings.
 - 4. Provide minimum of ten pipe diameters of straight pipe length upstream and downstream of meter vault.

3.2 METER FITTING HOOKUP

- A. Support meter piping and meter, level and plumb, during installation. Support meters 3 inches and larger with concrete at minimum of two locations.

- B. Use round flanged fittings inside meter box or vault except for mechanical joint to flange adapter. Provide full-face 1/8-inch black neoprene or red rubber gasket material on flanged joints. Provide bolts and nuts made from approved corrosion-resistant material.
- C. Tighten bolts in proper sequence and to correct torque.
- D. Visually check for leaks under normal operating pressure following installation. Repair or replace leaking components.

3.3 METER BOX AND VAULT INSTALLATION

- A. Conform to requirements of Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.
- B. Perform adjustment to existing meter in accordance with Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

3.4 BASEMENT INSTALLATIONS FOR METERS

- A. All piping within meter easement inside the building in basement must be welded steel to conform to section 02502 or restrained Ductile Iron to conform to section 02501. All transitions from PVC to Steel or Ductile iron must be made on the exterior side of the basement wall. All materials must be on the City approved list of materials.
 - 1. The meter piping must conform to the City of Houston detail drawings for typical meter piping arrangement.
 - 2. All pipes must be installed straight into the building.
- B. 3" and larger meter installations for basements must be approved by the water service provider for billing. Electromagnetic meter shall be from the City of Houston's Approved Products List.
- C. New customer must provide a NEMA type 4 enclosure 20"H x 16"W x 10"D for the mounting and containment of the meter electronics. The 120AC receptacle and phone jack must be installed in the enclosure. For existing meter replacements coordinate with customer and water provider as appropriate.
- D. The new customer must provide and maintain 120AC power and phone line within five feet of the meter location. For existing meter replacements coordinate with customer and water provider as appropriate.
 - 1. The 120AC power must terminate with a GFI protected receptacle and be connected to the structures emergency back up power.

- E. The new customer must provide a phone line which can be a shared phone line. For existing meter replacements coordinate with customer and water provider as appropriate.
 - 1. Phone line must terminate with a phone jack inside the service rack enclosure.
- F. The new customer will be required to give the water provider the appropriate size meter easement, with a minimum 8 feet clearance between floor and ceiling.
 - 1. Meters installed in an interior room must be fitted with double doors for easy equipment access. A floor drain must be installed within the meter easement for water drainage.
 - 2. The meter must be placed on the same floor level that the service line enters the structure. The service line must enter through the wall of the building. Use link seal method for pipe penetration thru wall as shown in details on the drawings.
 - 3. The customer or property owner shall keep the space occupied by the meter free from rubbish or obstruction of any kind, and provide access when required by the Authority.

3.5 CONTRACT METER INSTALLATIONS

- A. All contract potable water and raw water accounts are required to install the Authority's approved for billing electromagnetic meter from the City of Houston's Approved Products List. For existing meter replacements not part of the Authority's system, coordinate with customer and water provider as appropriate.
 - 1. With exception of Emergency Backup System (EBS) meter which will be the approved mechanical type meter for the application.
- B. All meter vaults must be designed to the Authority's standard detail drawings.
 - 1. Meter installations larger than 10" that cannot be installed within the standard vault, or meter installations in potential hazardous chemical environs must be installed above ground.
 - 2. The Engineer must approve an above ground meter installation.
 - 3. All above ground meter installations must be painted to Authority standards and have freeze protection.
 - 4. Above ground meter installations must have an 8'tall perimeter fence with a gate when it is not inside a water plant facility.

- C. All meter installations require meter easements and require a water line easement when meter easement is not adjacent to the Right of Way.
1. All meters that are not located adjacent to the Public Right of Way must have an all weather hard surface road to the meter location.
- D. All contract account customers must supply 120 AC voltage with a GFI receptacle and phone service with phone jack to be terminated in a NEMA type 4 enclosure 20"H x 16"W x 10"D at the meter location.
1. Electrical service to the Authority meter station must be connected to the back up generator when installed within the districts plant facility.
 2. 1" PVC electrical conduit must be installed from the enclosure to the meter for the meter electronics.

Note: No customer will be allowed to share, spilt, duplicate, or disrupt any signal generated from the City of Houston meter.

3.6 TESTING

- A. Accuracy registration tests will be conducted in accordance with latest revision of AWWA standard for type and size of meter.
1. Tests will be run on meters prior to installation. Meters 2 inches and smaller will be tested at random at Authority's discretion. All 3 inches and larger meters will be tested.
 2. Accuracy of displacement meters during guarantee period shall be as follows:
 - a. Initial period: of 18 months from date of shipment or 12 months from date of installation: 98.5% to 101.5% at standard and minimum flow rates; 98% to 101% at low flow rates.
 - b. Second period: AWWA new meter accuracy as tested below.

<u>GUARANTEE PERIOD</u>			<u>TEST FLOW RATE</u>	
<u>Meter Size</u> <u>(inches)</u>	<u>Age of</u> <u>Meter</u>	<u>Or</u>	<u>Million*</u> <u>Gallons</u>	<u>Minimum</u> <u>Rate (gpm)</u>
	<u>Years</u>			

5/8	>1 to <5	0.5	1/4
1	>1 to <5	1.0	3/4
1-1/2	>1 to <5	2.5	1-1/2
2	>1 to <5	5.5	2

* Total registration.

- c. Third period: AWWA new meter accuracy for standard flow rates and AWWA repair meter accuracy for minimum flow rate as tested below.

Meter Size (inches)	<u>GUARANTEE PERIOD</u>		<u>TEST FLOW RATE</u>		
	Age of Meter Years	Or Million* Gallons	Standard Flow Rates (gpm)	and	Minimum Rate (gpm)
5/8	>5 to <10	1.5	2-15		1/4
1	>5 to <10	2.5	4-40		3/4
1-1/2	>5 to <10	5.0	8-50		1-1/2
2	>5 to <10	10.0	15-100		2

* Total registration.

3. Minimal acceptable accuracy in percent of low flow registration for turbine meters:

<u>Meter Size</u> (inches)	<u>Minimum Flow</u> (gpm)	<u>% Accuracy Required</u>
2	3	95
3	5	95
4	15	95
6	20	95
8	20	95
10	30	95

END OF SECTION

Section 02527

**POLYURETHANE COATINGS
FOR STEEL OR DUCTILE IRON PIPE**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Polyurethane coating system for use as internal lining and external coating on steel pipe, and as external coating on ductile iron pipe.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. No separate payment will be made for work performed under this Section. Include cost of polyurethane lining or coating in contract unit prices for steel pipe or ductile iron pipe.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ANSI/NSF Standard 61 - Drinking Water System - Health Components.
- B. AWWA C 222 - Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
- C. ASTM D 16 – Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products.
- D. ASTM D 522 - Standard Test Method for Mandrel Bend Test of Attached Organic Coatings.
- E. ASTM D 570 – Standard Test Method for Water Absorption of Plastics
- F. ASTM D 4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- G. ASTM D4285 – Standard Test Methods for Indicating Oil or Water in Compressed Air

- H. ASTM D 4541 – Standard Test Method for Pull Off Strength of Coatings Using Portable Adhesion Testers
 - I. ASTM D7393 – Standard Practice for Indicating Oil in Abrasives
 - J. ASTM E 96 – Standard Test Method for Water Vapor Transmission of Materials
 - K. ASTM G 14 – Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
 - L. ASTM G 95 – Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)
 - M. NACE SP-0188 – Discontinuity (Holiday) Testing of Protective Coatings
 - N. NACE RP-0287 - Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
 - O. NAPF 500-03 – Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
 - P. SSPC-PA 2 - Measurement of Dry Paint Thickness with Magnetic Gauges.
 - Q. SSPC-PA Guide 10 - A Guide to Safety and Health Requirements.
 - R. SSPC-SP 1 – Solvent Cleaning Surface Preparation
 - S. SSPC-SP10 - Near-White Metal Abrasive Blast Surface Preparation
 - T. SSPC-SP11 – Power Tool Clean to Bare Metal
- 1.4 SAFETY
- A. Secure, from manufacturer, Material Safety Data Sheet (MSDS) for polyurethane coatings and repair materials listed in this Section.
 - B. Safety requirements stated in this specification and in related sections apply in addition to applicable federal, state and local rules and regulations. Comply with instructions of coating manufacturer and requirements of insurance underwriters.
 - C. Follow handling and application practices of SSPC-PA Guide 10, and Coating Manufacturer's Material Safety Data Sheet.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit coating manufacturer's catalog sheets, product data sheets, material data sheets and other manufacturer's information for all material provided. Include manufacturer's recommendation and instructions for surface preparation, application and curing.
- C. Quality Control Submittals. Furnish the following:
 - 1. Shop and field applicator's experience with list of references substantiating compliance. Submit references of 5 successful projects completed within the last 3 years for each applicator. Each project listed should be at least 500 linear feet in length, unless otherwise approved by Engineer.
 - 2. Monitoring records for shop coated pipe, including coating "affidavit of compliance" with requirements of this Section stating that coatings were applied in factory, in accordance with coating manufacturer's requirements, and AWWA C222.
 - 3. Factory applied linings and coatings: Lining/Coating manufacturer's certification stating that the individual applicators have met the qualification certification requirements as specified in this Section.
 - 4. Upon Engineer's request, provide:
 - a. Manufacturer's lining/coating application Quality Control Manual.
 - b. Coating Performance Test report with statement that no reformulations have been made subsequent to the coating tests performed for the report.
 - c. Current test equipment calibration certificates
 - 5. Provide administrative documents showing that QA/QC personnel in both shop and field are certified as NACE International Coating Inspector (Level III).
 - 6. Field applied linings and coatings:
 - a. Environmental monitoring records.
 - b. Field repair procedures.

1.6 QUALITY ASSURANCE

- A. Shop and Field Lining/Coating Applicator's Experience and Certification:
 - 1. Minimum 5 years' practical experience in application of the specified products

required for Lining/Coating Applicator and the Applicator's Supervisor (Certified Applicator).

2. Minimum 2 years' practical experience in application of the specified lining/coating system required and application personnel whom have direct application responsibility.
 3. Certification by lining/coating manufacturer as an approved applicator required for Lining/Coating Applicator.
- B. Shop: Unless otherwise approved by Engineer, lining/coating manufacturer's technical representative to be present for a minimum of three working days for technical assistance and instruction at the start of coating operations within the shop. During this visit, technical representative to observe surface preparation and application, and conduct or observe tests of coating to ensure conformance with application instructions, recommended methods, and conditions.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Use standard closed containers to prevent gelling, thickening deleteriously or forming of gas within period of one year from date of manufacture.
- B. Label each container of separately packaged component clearly and durably to indicate date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name or formula specification, number of coatings together with special instructions. Do not use coating components older than one year.
- C. Deliver coating materials to pipe manufacturer in sealed containers showing designated name, batch number, color, date of manufacture and name of manufacturer.
- D. Store material onsite in enclosures, out of direct sunlight in warm, ventilated and dry area. Protect from freezing.
- E. Prevent puncture, inappropriate opening or other action which may lead to product contamination.

1.8 OBSERVATION OF WORK

- A. Provide minimum 14 days advance notice to Engineer before start of coating work to allow for scheduling of shop or field observation.
- B. Provide full access to Engineer for all facilities and documentation regarding surface preparation, environmental conditions and applications.
- C. Observation by Engineer or waiver of observation does not relieve Contractor of his

responsibility to perform work in accordance with Specifications.

- D. Materials are subject to testing for conformance with this specification.
- E. Engineer may retain services of independent, third-party NACE CIP Level 3 Certified Inspector for partial or full-time inspection of the work.

PART 2 P R O D U C T S

2.1 GENERAL

- A. Supply lining or coating material in new, undamaged, labeled, unopened containers clearly and durably displaying date of manufacture, manufacturer's batch number, component identification, component color, manufacturer's name and product name. Store and handle in accordance with manufacturer's written instructions. Discard material that exceeds manufacturer's recommended shelf life, or is stored improperly, prior to usage, and replace with new material.
- B. Clean, prime, and coat surfaces of pipe and fittings in accordance with referenced standards, written instructions by coating manufacturer, and these specifications.
- C. Provide lining and coating materials from single manufacturer. Product substitutions during project are not permitted without approval from Engineer.

2.2 COATING MATERIAL

- A. Coating System: ASTM D16 Type V thermoset, aromatic polyurethane plastic polymer in accordance with AWWA C222 (referred to as a polyurethane system).
- B. Acceptable Materials:
 - 1. DuraShield 110, 210, and 310 (External); DuraShield 110-61 NSF, 210-61 NSF, and 310-61 NSF (Internal) by LifeLast Inc., Pflugerville, TX,
 - 2. CorroPipe 3000 (External); CorroPipe II PW (Internal) by Valspar, Minneapolis, MN.
 - 3. Protec II (External), Protec II PW (Internal) by ITW PolySpec/Futura Coatings, Houston, TX.
 - 4. Polyclad 777PL (External), Polyclad 767 (Internal), by Carboline, St. Louis, MO.
 - 5. Approved equal.

- C. Color: Polyurethane shall be light colored (white, tan, beige, almond, yellow)
- D. Cured Coating Properties. In accordance with AWWA C222 except as follows:
 - 1. ASTM E 96 Permeance using Water Procedure BW (App. X1): no more than 0.16 inch-lb.

2.3 SURFACE PREPARATION

- A. The requirements listed below are for surface preparation procedures in the factory. For surface preparation in the field, refer to Part 3 – Execution.
- B. Steel Pipe: In accordance with coating manufacturer's requirements.
- C. Ductile Iron Pipe. Prepare surface in accordance with manufacturer's recommendations and NAF 500-03.
 - 1. Provide uncoated ductile iron pipe when polyurethane coatings are used. Do not apply asphaltic coating to ductile iron pipe and then attempt to remove prior to polyurethane coating application.
 - 2. Do not apply surface preparation that is designed for steel pipe to ductile iron pipe. Unlike steel surfaces, it is possible to over blast the external surface of ductile iron pipe. Consult ductile iron pipe and polyurethane coating manufacturer regarding method of application and surface preparation to be used.

2.4 FACTORY APPLICATION OF POLYURETHANE

- A. Equipment: As required by manufacturer.
- B. Temperature: Minimum 5 degrees F above dew point temperature. Temperature of surface shall not be less than 50 degrees F during application or as per manufacturer's recommendation, whichever is higher.
- C. Humidity: Heating of pipe surfaces may be required when relative humidity exceeds 80 percent.
- D. Do not thin or mix resins; use as received. Store resins at temperature between 60 and 90 degrees F at all times.
- E. Application: Conform to lining/coating manufacturer's recommendations. Apply directly to substrate to achieve specified thickness. Multiple-pass, one-coat application process is permitted provided maximum allowable recoat time specified by manufacturer is not exceeded.

- F. Recoat only when lining or coating has cured less than maximum time specified by coating manufacturer. When coating has cured for more than recoat time, follow coating manufacturer's recommendations for recoating.
- G. Cure and perform cure test in accordance with manufacturer's recommendations prior to handling, inspection, testing, and placement in service.

2.5 FACTORY INSPECTION

- A. Engineer may inspect linings and coatings at applicator's facilities.
- B. Inspection procedures to be in accordance with AWWA C222 and noted herein. Conduct inspection any time after lining or coating has reached initial cure. Repair in accordance with coating manufacturer's requirements and these specifications.

1. Surface Profile Testing

- a. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP0287.
- b. Tester tape shall be suitable for the intended profile height.
- c. Profile shall be measured to a minimum tolerance of 0.1 mils.

2. Visual Inspection Testing

- a. Visual inspection and testing shall be conducted at the shop after the lining per AWWA C205 or polyurethane coating has completely cured and prior to shipment per AWWA C222. Pipe lots shipped without visual inspection testing shall be field-tested. Pipe rejected in the field shall be returned to the shop for repair at the sole expense of the Contractor.
- b. Visual inspection testing shall be conducted on each pipe lot lined or coated. The sample quantity of visual inspection tests shall be the greater of the following:
 - 1. Five randomly selected pipes from each pipe lot shall be tested.
 - 2. Not less than 50 percent of pipe produced within a lot.
- c. If any two individual pipe of the sample quantity fail the visual inspection as required by AWWA C222 Section 5.5.2, the entire lot will be held in dispute (quarantine).

3. Adhesion Testing

- a. Adhesion testing shall be conducted at the shop after the lining or coating has completely cured and prior to shipment. Pipe lots shipped without adhesion testing shall be field-tested. Pipe rejected in the field shall be returned to the shop for repair at the sole expense of the Contractor.
- b. Adhesion testing shall be conducted on each pipe lot coated. The quantity of coating adhesion tests shall be the greater of the following:
 1. Five randomly selected pipes from each pipe lot shall be tested.
 2. Not less than 50 percent of each pipe produced within a lot.
- c. Adhesion testing shall be conducted after all repair or replacement of coating application equipment that comes in contact with uncured polyurethane. Test the last pipe lined or coated prior to and the first pipe lined or coated after the changes.
- d. The applicator shall repair all lining or coating damage from shop adhesion testing. Repairs to adhesion tests shall not be counted against the total minor repairs allowable.
- e. Adhesion tests shall be performed after the lining or coating has initially cured but not less than 24 hours after application. Tests conducted prior to 24 hours shall be acceptable only if the test meets or exceeds the adhesion criteria specified and the test was requested by the Lining/Coating Applicator.
- f. Pipe shall be randomly selected for adhesion testing by the Lining/Coating Applicator.
- g. Perform adhesion testing in accordance with AWWA C222. Acceptance criteria for scored dolly testing shall be as defined in AWWA C222 minimum 1,500 psi. The adhesion test criteria is not satisfied if any adhesive or cohesive mode failure of the coating occurs at an applied tension at or below the acceptance criteria. Glue failures greater than 50% of the dolly surface area and at a pull value below the criteria are considered to be a non-test and the test must be repeated.
- h. Rejection of Lining or Coating
 1. Each pipe failing the adhesion criteria as defined this section shall be rejected.
 2. If tested pipe within a lot fails to meet the adhesion criteria specified for the lining or coating type, each pipe within that lot shall then be individually

tested and accepted or rejected on a pipe-by-pipe basis in conformance with the test procedures. A failure in one section of the pipe shall be retested per AWWA C222.

3. All rejected pipe shall have the lining or coating fully removed from the pipe and the pipe abrasive blasted and recoated.

- i. Engineer has the right to conduct additional adhesion testing as deemed necessary to assure the pipe meets the requirements of this specification prior to shipment.

4. Dry Film Thickness Testing

- a. Linings and coatings shall be tested for dry film thickness using a properly calibrated Positector 6000 Type II gauge or approved equal.
 - b. Lining or coating thickness measurements shall be conducted in accordance with AWWA C222 without limitation to additional measurements as may be deemed necessary.

5. Holiday Testing

- a. Holiday tests shall be conducted on the completed coating after the lining or coating has cured to a firm state, follow the manufacturer's recommended timing. Holiday test shall be conducted using a high voltage spark test in accordance with NACE Standard SP0188 and these specifications.
 - b. Testing voltage shall be set at the actual coating thickness using manufacturer's testing voltage recommendation except the minimum shall be 100 V/mil.

- C. Unacceptable Lining or Coating Application

1. Applied under improper environmental conditions shall be rejected.
 2. Pipes that exceed the allowable quantity of defects, regardless of size or cause, shall be rejected.
 3. Linings or coatings that fail the adhesion or holiday testing as specified in this section shall be rejected. Holidays may be repaired without stripping the rejected pipe, but the restrictions regarding frequency and total surface area of repair as stated in this section apply.
 4. Pipes that do not satisfy the minimum dry film thickness as specified shall be rejected.

5. Pipe lining or coating that is subject to off-ratio application, blistering, or is not applied in conformance with the coating manufacturer's written instructions or recommendations shall be rejected.
 6. Appearance shall be generally smooth and free of sharp protrusions. The lining or coating shall have no blisters, cracks, bubbles, delamination, or any other visual defects per AWWA C222 Section 5.5.2. All imperfections shall be identified and repaired.
- D. Remove lining or coating on the rejected pipe section for the full length of pipe to bare metal. Reapply using proper application methods.

2.6 HOLDBACK COATING SYSTEM

- A. Provide holding primer for corrosion protection of cutbacks or holdbacks compatible with specified joint coating system, heat shrink sleeve, and weld after backfill requirements where applicable.
- B. Holdback coating to prevent corrosion of prepared pipe ends for duration of storage and construction, and recommended for buried exposures.
- C. Primer should not result in running or melting of coating and causing toxic fumes when heated during welding on weld after backfill joints. Zinc primers are not allowed.
- D. Apply holding primer in accordance with primer manufacturer's recommendations, but maintain clearances required for proper joint installation as recommended by pipe manufacturer.
- E. Ductile Iron Joints: Apply coating to unlined pipe surfaces including inside of bell socket and outside of spigot. Coating application thickness on sealing areas of spigot end of pipe exterior: minimum 8 mils (0.008 inch), maximum of 10 mils (0.010 inch). Maximum 10 mils may be exceeded in spigot end provided maximum spigot diameter as specified by pipe manufacturer is not exceeded and approved by pipe manufacturer
- F. Welded joints:
 1. Field welded on the inside: Provide four-inch minimum coating holdback on spigot end and six-inch minimum coating holdback on bell end.
 2. Field welded on the outside: Provide six-inch minimum coating holdback on the spigot end, and four-inch minimum coating holdback on the bell end.
 3. Butt strap ends: Provide six-inch minimum coating holdback.

2.7 THICKNESS

- A. Internal Linings: Minimum DFT of 25 mils (0.025 inch) or manufacturer's recommendation, whichever is greater.
- B. External Coatings: Minimum DFT of 35 mils (0.035 inch) or manufacturer's recommendation, whichever is greater.
- C. Thickness Determinations: Use Type 1 magnetic thickness gauge as described in SSPC-PA2 specification. No single gauge reading may be less than specified thickness.
- D. Do not accept pipe with deficient coating thickness. If pipe in field is found to have a lining or coating thickness as measured by SSPC PA-2 that is less than the specified thickness, the pipe segment shall be rejected.

2.8 FACTORY REPAIR OF INTERNAL LININGS AND EXTERNAL COATINGS

- A. The procedures listed below are for repairs made to internal linings and external coatings in the factory. For field repairs, see Part 3 – Execution.
- B. General
 - 1. Repair areas where holidays are detected or lining or coating is visually damaged, such as blisters, bubbles, cuts, or other defects.
 - 2. Provide coating repair materials that are compatible with the shop-applied system and approved by coating manufacturer.
 - 3. Provide repair materials as required for the system and repair classification.
- C. Repair Materials:
 - 1. Provide polyurethane, single use kits that are supplied by parent coating manufacturer.
 - 2. For major repairs in the shop, reapply using plural component spray equipment by a manufacturer certified coating Applicator.
- D. Defect size is defined as follows:
 - 1. Minor – less than 6 inches by greatest dimension.
 - 2. Major – exceeds 6 inches by greatest dimension.

- E. Maximum quantity of defects allowed:
 - 1. Minor repairs on all pipes shall not exceed 1.5 repairs per 100 square feet of surface area.
 - 2. Major repairs shall not exceed one per pipe.
 - 3. The combined area of all major and minor repairs for each pipe shall not exceed 0.5 percent of the pipe surface area

PART 3 EXECUTION

3.1 FIELD ENVIRONMENTAL CONTROLS

A. General

- 1. Do not apply linings or coatings when:
 - a. Surface or ambient temperatures exceed the maximum or minimum temperatures recommended by the lining or coating manufacturer.
 - b. In dust or smoke-laden atmosphere, blowing dust or debris, or under conditions that can cause icing on metal surface.
 - c. When it is expected surface temperatures may drop below 5 degrees above dew point within 1 hour after application of coating.
 - d. Whenever relative humidity exceeds 85 percent or the maximum recommended by the lining or coating manufacturer.
- 2. When weather conditions dictate, provide and operate heaters and dehumidification equipment to allow pipe surfaces to be prepared and lined or coated as specified and in accordance with the manufacturer's application recommendations.
- 3. Do not proceed with surface preparation and application activities until adequate temperature and humidity controls are in place and functioning within environmental limits specified.
- 4. Monitor ambient temperature, relative humidity, dew point, temperature, and pipe surface temperature (work area only) in strict conformance with manufacturer's requirements, but not greater than 5 hours between measurements. Document and submit environmental monitoring records to Engineer upon completion, if requested.

3.2 PIPE INSTALLATION

- A. When required by Engineer, provide services of pipe manufacturer's representative for

period of not less than 2 weeks at beginning of actual pipe laying operations to advise Contractor regarding installation including but not limited to handling and storing, cleaning and inspecting, coatings repairs, and general construction methods as to how they may affect pipe coatings.

- B. When required by Engineer, lining or coating manufacturer's technical representative shall provide a written report to the Engineer for each visit. Include copies of test data collected, description of observations, and all recommended corrective actions. Submit within five working days after the visit. After corrective actions are complete, representative to certify application complies with manufacturer's application recommendations.
- C. Use nylon straps, padded lifts and padded storage skids. Field cuts should be kept to minimum. Repair damage to lining or coating due to handling or construction practices.
- D. Just before each section of pipe is to be placed into trench, conduct visual and holiday inspection in accordance with AWWA C222. Repair defects in lining or coating system before pipe is installed.
- E. For field-welded joints, drape minimum 18-inch wide strip of heat-resistant material over top half of pipe on each side of the coating holdback to protect from weld spatter. For internal welds, comply with lining manufacturer's recommendations for protecting lining during welding activities.
- F. Provide transition from cement mortar lining to polyurethane lining in accordance with coating manufacturer's recommendations and as approved by Engineer.

3.3 FIELD REPAIR AND TOUCHUP

- A. Apply repair and touchup materials in conformance with manufacturer's recommendations.
- B. Repair Procedure – Joints:
 - 1. External Joints. Provide heat shrink sleeve in accordance with Section 02518 – Steel Pipe for Large Diameter Water Lines. Metal surface must be free of all dirt, dust, and surface corrosion prior to sleeve application. Where corrosion in the holdback area is visible, prepare surface in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal for steel pipe, or NAPF 500-03-03 Power Tool Cleaning for ductile iron pipe.
 - 2. Internal Joints. Prepare surface and provide environmental controls in accordance with manufacturer's recommendations.
 - a. Remove oil or grease by solvent wiping pipe and adjacent coating in accordance

with SSPC-SP1, Solvent Cleaning.

b. Clean pipe surface in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal or abrasively blast in the field in accordance with SSPC-SP10, Near-White Metal Blast Cleaning. Clean the full circumference of the pipe and feather the edges of the existing polyurethane coating a minimum of two inches.

c. Remove loose or damaged pipe lining at joint and repair as specified herein, or extend joint lining.

d. Apply lining material by hand or spray equipment. Provide material that is compatible with shop lining and approved by manufacturer.

e. Provide a NACE Level II or III inspector experienced with the applied coating system to inspect surface preparation of the joint lining and document application conditions. Submit documentation to Project Manager.

C. Repair Procedure – Field Defects:

1. Repair Materials (subject to Engineer's approval):

- a. Heat-applied repair patches
- b. Single use polyurethane lining or coating kits that control mix ratios
- c. Lining or coating manufacturer's polyurethane repair products

2. Repair Procedures:

- a. Solvent clean in accordance with SSPC-SP1 for steel pipe or NAPF 500-03-01 for ductile iron pipe.
- b. Power tool clean in accordance with SSPC-SP11 for steel pipe and NAPF 500-03-03 for ductile iron pipe. Feather the lining or coating and provide overlap in accordance with a manufacturer's recommendations.
- c. Apply repair material as described above in accordance with manufacturer's recommendations.
- d. If a heat-applied repair patch is used, do not overlap patches or use more than one patch for a single repair. If repair area exceeds the size of a single patch, use alternate repair method as listed above.

D. Repair Procedure - Thermite Brazed Connection Bonds:

1. Remove polyurethane coating with power wire brush from area on metal surface which is to receive thermite brazed connection.
2. Grind metal surface to shiny metal with power grinder and coarse grit grinding wheel.
3. Apply thermite-brazed connection using equipment, charge and procedure recommended by manufacturer of thermite equipment.
4. Drape minimum 18-inch wide strip of heat-resistant material over top half of pipe on all sides during welding to protect from weld spatter.
5. After welded surface has cooled to temperature below 130 degrees F, apply protective lining or coating repair material to weld, exposed pipe surface and damaged areas of polyurethane lining or coating. A heat-applied repair patch may be used as approved by Engineer.
6. Do not cover or backfill freshly repaired areas of coating at thermite-brazed connections until repair material has completely cured. Allow material to cure in conformance with manufacturer's recommendations.

END OF SECTION

Section 02528

POLYETHYLENE ENCASEMENT/WRAP

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Polyethylene encasement that may be part of the corrosion protection system for pipe, valves, fittings, and other appurtenances in ductile or cast iron systems.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for polyethylene wrap. Include cost of polyethylene wrap in unit price for pipes and fittings to be wrapped.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM D 149 – Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
- B. ASTM D 882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- C. ASTM D 1709 – Standard Test Methods for Impact Resistance of Plastic Film by the Free- Falling Dart Method.
- D. ASTM D 1922 – Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method.
- E. ASTM D 4976 – Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
- F. ANSI/AWWA C600 – Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

- G. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.

1.4 SUBMITTALS

- A. Submittal Procedures: Submit product data in accordance with Section 01330 - Submittal Procedures.
- B. Product Data: Submit product data for proposed film, and tape or plastic tie straps for approval. All film to be used in accordance with this standard specification will be manufactured from virgin polyethylene, will not be recycled and shall be purchased new for the project, clean, sound and without defects.
- C. Samples: Submit samples of polyethylene tube and/or sheet for approval. Provide one sample of tube for each pipe diameter and one sample of each sheet material to be used. Samples will be a minimum of 40 square feet of standard production material.
- D. Quality Assurance Plan: Submit quality assurance plans for film manufacturing and field application.
1. Film Manufacturing: The manufacturer of polyethylene film for corrosion protection encasement of ductile iron pipe will have a verifiable quality control system to assure that film is produced from only virgin polyethylene and that it complies with all requirements of this specification. Documentation of Quality Control procedures and test results will be submitted and will be made available for inspection for at least one year subsequent to delivery to job site.
 2. Field Application: The contractor will develop, and submit for approval, a comprehensive Quality Assurance Plan for installation of polyethylene encasement. Address all aspects of material and pipe handling, bedding, preparation of pipe surface, film installation and anchoring, service taps and backfill. Include written procedures to be used by installers.
- E. Manufacturer's Certification: Submit polyethylene film manufacturer's certification of compliance with this Section. The polyethylene film manufacturer will provide a notarized statement from an officer of the company that the film meets the inspection and all applicable material specifications of this specification. The manufacturer's statement of compliance must be verifiable. Statements from distributors or contractors will not be accepted in lieu of a statement from the original manufacturer of the polyethylene film.
- F. Installer Qualifications: Polyethylene encasement will only be installed by qualified persons who have been trained in the proper procedures described in Part 3 of these specifications. Qualified Persons: Qualified persons shall be those

that have had training and experience in the installation of polyethylene encasement for corrosion protection of ductile iron pipe. Such persons may be qualified by the Ductile Iron Pipe Research Association, ductile iron pipe manufacturers or engineering/inspection firms who offer training courses in the proper method(s) of installation. Proof of qualifications shall be submitted with the shop drawings and shall be provided to project representatives upon request.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Polyethylene Film: Tubular or sheet form without tears, breaks or defects, conforming to the following requirements.
 - 1. High-Density, Cross-Laminated, Polyethylene: High-density, cross-laminated polyethylene film manufactured from virgin polyethylene material conforming to the following:
 - a. Raw Material. Raw materials to meet the requirements of ASTM D 4976:
 - 1. Group: 2 (Linear)
 - 2. High-density: 0.940 to 0.960 g/cm³
 - 3. Volume resistivity: 10¹⁵ ohm-cm, minimum
 - b. Physical Properties. Physical properties of finished film to be as follows:
 - 1. Tensile Strength: 6,300 psi, minimum in machine and transverse direction (ASTM D 882).
 - 2. Elongation: 100 percent, minimum in machine and transverse direction (ASTM D 882) as measured using rubber lined grips.
 - 3. Dielectric Strength: 800 volts/mil thickness, minimum (ASTM D 149)
 - 4. Impact Resistance: 800 grams, minimum (ASTM D 1709 Method B)
 - 5. Propagation Tear Resistance: 250 grams force, minimum in machine and transverse direction (ASTM D1922)

- c. Thickness: High-density, cross-laminated polyethylene film shall have a nominal thickness of 0.004 in. (4 mils) with a minus 10% tolerance. No where shall the film be less than 0.0036 (3.6 mils).
- d. Color: Supply white polyethylene film with a minimum 2 percent hindered-amine ultraviolet inhibitor.
- e. Polyethylene Tube and Sheet Size: For push-on joint pipe, polyethylene tube and sheet sizes to conform to the following:

Nominal Diameter (Inches)	Pipe Minimum Polyethylene Width (Inches)	
	<u>Flat Tube</u>	<u>Sheet</u>
3	14	28
4	14	28
6	16	32
8	20	40
10	24	48
12	27	54
14	30	60
16	34	68
18	37	74
20	41	82
24	54	108
30	67	134
36	81	162
42	81	162
48	95	190
54	108	216
60	108	216
64	121	242

- 2. Large Bell Circumferences: Where bell ends of the pipe are larger than the sheet sizes listed above, use sufficiently large tubes or sheets to cover the joints
- 3. Marking: The polyethylene film will be clearly marked every two feet with the following information:
 - a. Manufacturer's name or trademark
 - b. Year of manufacture
 - c. ANSI/AWWA C105/A21.5
 - d. Minimum film thickness and material type(HDCLPE)

e. Applicable range of nominal pipe diameter size(s)

f. Warning – Corrosion Protection – Repair Any Damage

Letters and numerals used for marking items "a" through "e" shall not be less than 1 inch in height and item "f" shall not be less than 1 1/2 inches in height.

- B. Plastic Tape: Provide 1 ½-inch wide, 6 mil thick, PVC tape with 5 mils of PVC backing and 1 mil of rubber adhesive for fitting, anchoring and repairing the encasement.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove lumps of clay, mud, and cinders from pipe surface prior to installation of polyethylene encasement. Prevent soil or embedment material from becoming trapped between pipe and polyethylene.
- B. Fit polyethylene film to contour of pipe to effect a snug, but not tight fit; encase with minimum space between polyethylene and pipe. Allow sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces, bolted joints, or fittings, and to prevent damage to polyethylene due to backfilling operations. Secure overlaps and ends with adhesive tape to hold polyethylene encasement in place until backfilling operations are complete.
- C. For installations below water table or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap. Circumferentially wrap with tape, every two feet along the barrel.

3.2 INSTALLATION

- A. Tubular Type (Method A):
1. Cut polyethylene tube to a length approximately 2 feet longer than pipe section. Slip tube around pipe, centering tube to provide 1-foot overlap on each adjacent pipe section. Bunch accordion-fashion lengthwise until it clears pipe ends.
 2. Make shallow bell hole at joints to facilitate installation of polyethylene tube completely around pipe. Lower pipe into trench and make up pipe joint with preceding section of pipe. Methods other than bell holes shall be

allowed, provided the polyethylene tube completely encases the pipe joints, including a minimum overlap of 1-foot.

3. After assembling pipe joint, make overlap of polyethylene tube. Pull bunched polyethylene from preceding length of pipe, slip it over end of adjoining length of pipe, and secure in place. Then slip end of polyethylene from adjoining pipe section over end of first wrap until it overlaps joint at end of preceding length of pipe. Secure overlap in place.
4. For each pipe length, take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold with tape at quarter points. Avoid a tight fit to prevent stretching the polyethylene where it bridges irregular surfaces, such as bell and spigot joints, restrained and bolted joints, and fittings; and to prevent damage to film during backfilling. The length of tape to secure wrap shall be no less than 1-foot.
5. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

B. Tubular Type (Method B):

1. Cut polyethylene tube to a length approximately 1 foot shorter than pipe section. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end.
2. Make shallow bell hole at joints to facilitate installation of polyethylene tube completely around pipe. Lower pipe into trench and make up pipe joint with preceding section of pipe. Methods other than bell holes shall be allowed, provided the polyethylene tube completely encases the pipe joints, including a minimum overlap of 1-foot.
3. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold with tape at quarter points. Avoid a tight fit to prevent stretching the polyethylene where it bridges irregular surfaces, such as bell and spigot joints, restrained and bolted joints, and fittings; and to prevent damage to film during backfilling. The length of tape to secure wrap shall be no less than 1-foot.
4. Before making up joint, slip 4-foot length of polyethylene tube over end of preceding pipe section, bunching in accordion-fashion lengthwise. After completing joint, pull 4-foot length of polyethylene over joint, overlapping polyethylene previously placed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.

5. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.
- C. Sheet Type (Method C) – Applicable to Valves, Tees, Elbows and Other Fittings Only:
1. Cut polyethylene sheet to a length approximately 2 feet longer than pipe section. Center length to provide 1-foot overlap on each adjacent pipe section, bunching sheet until it clears pipe ends. Wrap polyethylene around pipe so that sheet circumferentially overlaps top quadrant of pipe. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
 2. Lower wrapped pipe into trench and make up pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene. After completing joint, make overlap and secure ends.
 3. Repair cuts, tears, punctures, or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.
- D. Installation in Augured Hole or Directional Drilled Bore:
- E. Install as described in 3.02A. Tubular Type (Method A) with the exception that the polyethylene encasement overlap must face away from the pull direction to avoid the under film accumulation of drilling mud and other foreign matter.
- F. Attach pulling head to spigot end of the leading pipe length.
- G. Securely anchor the polyethylene tube to the end of the barrel of the leading pipe length by continuously taping the leading two feet of the barrel with overlapping tape wrap. Anchor the first wraps of tape directly on to the barrel of the pipe and extend the continuous taping on to the polyethylene encasement. For the remainder of the leading pipe length, overlap circumferential wraps of tape every one foot.
- H. The drilling fluid and cuttings shall not enter under the polyethylene tube during the pull back or other operations. At assembled joints, the polyethylene overlap shall always have the forward pipe's polyethylene tube overlap the next following pipe's tube. The polyethylene on both sides of the joint shall be secured with circumferential wraps of tape or plastic tie straps.
- I. Continue process by wrapping tape on each side of successive joints and every two feet along barrel.
- E. Pipe-shaped Appurtenances: Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in same manner as pipe.

- F. Odd-shaped Appurtenances: When it is not practical to wrap valves, tees, crosses, and other odd- shaped pieces in tube, wrap with flat sheet or split length of polyethylene tube by passing sheet around appurtenance and encasing it. Make seams by bringing edges together, folding over twice, and taping down. At valve stems and other penetrations, secure polyethylene film with tape.
- G. Openings in Encasement: Create openings for branches, saddles, service taps, blowoffs, air valves, and similar appurtenances by making an X-shaped cut in polyethylene and temporarily folding back film. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene, with tape.
- H. Hydrant Drain Relief: For hydrant relief holes and similar orifices, apply 3 wraps of tape completely around the polyethylene encased pipe, then, with a utility knife, cut a hole in the tape and polyethylene that is 1-inch larger in diameter than the orifice/opening.
- I. Direct Service Taps: For direct service taps, apply 3 wraps of tape completely around the polyethylene encased pipe to cover the area where the tapping machine and chain will be mounted. After the tapping machine is mounted, install the corporation stop directly through the tape and polyethylene. After the direct tap is completed, the entire circumferential area shall be closely inspected and repaired as needed.
- J. Service Connections: Wrap service lines of copper and other dissimilar metals with polyethylene or suitable dielectric tape for a minimum clear distance of 3 feet away from the cast or ductile iron pipe. Surface preparation and method of application shall follow tape manufacturer's written instructions.
- K. Junctions between Wrapped and Unwrapped Pipe: Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for at least 3 feet. Secure end with circumferential turns of tape.
- L. Installation of Pipe through Casings: Polyethylene encasement shall be used for pipe through casings. Use a single layer of polyethylene film. Casing spacers (insulated type) and casing end seals shall be installed. Do not damage the polyethylene film where these devices are attached to the pipe, over the encasement.

3.3 REPAIRS

Repair any cuts, tears, punctures, or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around pipe to cover damaged area, and secured in place.

3.4 BACKFILL

Use the same backfill material as that specified for pipe without polyethylene wrap. Prevent damage to the polyethylene wrap when placing backfill. Assure backfill material is free from cinders, refuse, boulders, rocks, stones, or other material that could damage the polyethylene. Follow AWWA C600 for backfilling.

3.5 QUALITY ASSURANCE

- A. Freedom from Defects: All polyethylene film shall be clean, sound and free from defects.
- B. Inspection: All parts of this Section are subject to inspection by the Authority or its designated representative.
- C. Non-Compliance: The Contractor will correct any deficiencies in materials or installation at his expense, including excavating the pipe subsequent to backfilling and re-installing the polyethylene wrap.

END OF SECTION

Section 02531

GRAVITY SANITARY SEWERS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Gravity sanitary sewers and appurtenances, including stacks and service connections.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for gravity sanitary sewers by open-cut or within Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis, complete in place, including sewer pipe, connections to existing manholes, post installation television inspection, and testing. Measurement will be taken along centerline of pipe from centerline to centerline of manholes.
 - 2. Payment for television inspection of existing gravity sanitary sewers will be on a linear foot basis. Measurement will be taken along centerline of pipe from centerline to centerline of manholes. See Section 02558 - Cleaning and Television Inspection.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed methods, equipment, materials and sequence of operations for sewer construction. Plan operations so as to minimize disruption of utilities to occupied facilities or adjacent property.
- C. Test Reports: Submit test reports and inspection videos as specified in Part 3 of this Section. Videos become property of the Authority.

1.4 QUALITY ASSURANCE

- A. Qualifications. Install sanitary sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections. Perform testing in accordance with Section

02533 - Acceptance Testing for Sanitary Sewers.

B. Regulatory Requirements.

1. Install sewer lines to meet minimum separation distance from potable water lines, as scheduled below. Separation distance is defined as distance between outside of water pipe and outside of sewer pipe. When possible, install new sanitary sewers no closer to water lines than 9 feet in all directions. Where this separation distance cannot be achieved, new sanitary sewers shall be installed as specified in this section.
2. Make notification to Engineer when water lines are uncovered during sanitary sewer installation where minimum separation distance cannot be maintained.
3. Lay gravity sewer lines in straight alignment and grade.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Inspect pipe and fittings upon arrival of materials at job site.
- B. Handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear or free fall. Do not drag pipe and fittings along ground. Do not roll pipe unrestrained from delivery trucks.
- C. Use mechanical means to move or handle pipe. Employ acceptable clamps, rope or slings around outside barrel of pipe and fittings. Do not use hooks, bars, or other devices in contact with interior surface of pipe to lift or move lined pipe.

PART 2 PRODUCTS

2.1 PIPE

- A. Provide piping materials for gravity sanitary sewers of sizes and types indicated on Drawings or as specified.
- B. Unlined reinforced concrete pipe is not acceptable.
- C. Pipe shall be color coded green.

2.2 PIPE MATERIAL SCHEDULE

- A. Unless otherwise shown on Drawings, use pipe materials that conform to requirements specified in one or more of following Sections:

1. Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures.
 2. Section 02501 - Ductile Iron Pipe and Fittings.
 3. Section 02504 - Fiberglass Reinforced Pipe.
 4. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe.
 5. Section 02506 - Polyvinyl Chloride Pipe.
 6. Section 02508 - Extra Strength Clay Pipe.
 7. Section 02611 - Reinforced Concrete Pipe.
 8. Section 02532 – Sanitary Sewer Force Mains.
- B. Where shown on Drawings, provide pipe meeting minimum class, dimension ratio, or other criteria indicated.
- C. Pipe materials other than those listed above shall not be used for gravity sanitary sewers.

2.3 APPURTENANCES

- A. Vertical Stacks. Conform to requirements of Section 02534 - Sanitary Sewer Service Connections.
- B. Service Connections. Conform to requirements of Section 02534 - Sanitary Sewer Service Connections.
- C. Roof, street, or other type of surface water drains shall not be connected to sanitary sewer lines.

2.4 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

- A. Bedding and Backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities, Section 02320 - Utility Backfill Materials, and Section 02321 - Cement Stabilized Sand.
- B. Topsoil: Conform to requirements of Section 02911 - Topsoil.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation when construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation.
- B. Provide barricades, flashing warning lights, and warning signs for excavations. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights where work is in progress or where traffic is affected by work.
- C. Perform work in accordance with OSHA standards. Employ trench safety system as specified in Section 02260 - Trench Safety System for excavations over 5 feet deep.
- D. Immediately notify agency or company owning utility line which is damaged, broken or disturbed. Obtain approval from Engineer and agency or utility company for repairs or relocations, either temporary or permanent.
- E. Remove old pavements and structures including sidewalks and driveways in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- F. Install and operate dewatering and surface water control measures in accordance with Section 01578 - Control of Ground Water and Surface Water.
- G. Do not allow sand, debris or runoff to enter sewer system.

3.2 DIVERSION PUMPING

- A. Install and operate required bulkheads, plugs, piping, and diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from Engineer.
- B. Design piping, joints and accessories to withstand twice maximum system pressure or 50 psi, whichever is greater.
- C. No sewage shall be diverted into area outside of sanitary sewer.
- D. In event of accidental spill or overflow, immediately stop overflow and take action to clean up and disinfect spillage. Promptly notify Engineer so that required reporting can be made to Texas Commission on Environmental Quality (TCEQ) and Environmental Protection Agency by Engineer.

3.3 EXCAVATION

- A. Earthwork. Conform to requirements of Section 02317 - Excavation and Backfill

for Utilities. Use bedding as indicated on Drawings.

- B. Line and Grade. Establish required uniform line and grade in trench from benchmarks identified by Engineer. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of work. Use of appropriately sized grade boards which are substantially supported is also acceptable. Protect boards and location stakes from damage or dislocation.
- C. Trench Excavation. Excavate pipe trenches to depths shown on Drawings and as specified in Section 02317 - Excavation and Backfill for Utilities.

3.4 PIPE INSTALLATION BY OPEN CUT

- A. Install pipe in accordance with pipe manufacturer's recommendations and as specified in following paragraphs.
- B. Install pipe only after excavation is completed, bottom of trench fine graded, bedding material is installed, and trench has been approved by Engineer.
- C. Install pipe to line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in trench so interior surfaces of pipe follow grades and alignment indicated. Provide bell holes where necessary.
- D. Install pipe with spigot ends toward downstream end of flow such that water flows into bell and out the spigot.
- E. Form concentric joint with each section of adjoining pipe so as to prevent offsets.
- F. Keep interior of pipe clean as installation progresses. Remove foreign material and debris from pipe
- G. Provide lubricant, place and drive home newly laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Engineer.
- H. Keep excavations free of water during construction and until final inspection.
- I. When work is not in progress, cover exposed ends of pipes with approved plug to prevent foreign material from entering pipe.
- J. Where gravity sanitary sewer is to be installed under existing water line with separation distance of at least 2 feet and less than 9 feet, install new sewer pipe so that one full 18-foot long pipe is centered on water line crossing. Embed sewer pipe

in cement stabilized sand for minimum distance of 9 feet on each side of crossing.

- K. Where gravity sanitary sewer is to be installed under existing water line with separation distance of less than 2 feet, install new sewer using pressure-rated pipe as shown on Drawings. Maintain minimum 1 foot separation distance.

3.5 PIPE INSTALLATION OTHER THAN OPEN CUT

- A. For installation of pipe by augering, jacking, or tunneling, conform to requirements of specification sections for augering, jacking, tunneling and microtunneling work as appropriate.
- B. For rehabilitation of existing sewer lines, conform to requirements of specification Section 02550 - Sliplining, Section 02556 - Cured-In-Place Pipe, or Section 02571 - Pipe Bursting.

3.6 INSTALLATION OF APPURTENANCES

- A. Service Connections. Install service connections to conform to requirements of Section 2534 - Sanitary Sewer Service Stubs or Reconstructions.
- B. Stacks. Construct stacks to conform to requirements of 02534 - Sanitary Sewer Service Stubs or Reconstructions.
- C. Construct manholes to conform to requirements of Section 02081 - Cast-in-Place Concrete Manholes, Section 02082 - Precast Concrete Manholes, and Section 02083 - Fiberglass Manholes, as applicable. Install frames, rings, and covers to conform to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

3.7 INSPECTION AND TESTING

- A. Visual Inspection: Check pipe alignment in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Mandrel Testing. Use Mandrel Test to test flexible pipe for deflection. Refer to Section 02533 - Acceptance Testing for Sanitary Sewers.
- C. Pipe Leakage Test. After backfilling line segment and prior to tie-in of service connections, visually inspect gravity sanitary sewers where feasible, and test for leakage in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers. Maintain piezometer installed to conform with Section 01578 - Control of Ground Water and Surface Water, until acceptance testing is completed.

3.8 BACKFILL AND SITE CLEANUP

- A. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Backfill trench in specified lifts only after pipe installation is approved by Engineer.
- C. Repair and replace removed or damaged pavement, curbs, gutters, and sidewalks as specified in Section 02951 - Pavement Repair and Resurfacing.
- D. Provide hydromulch seeding in areas of commercial, industrial or undeveloped land use over surface of ground disturbed during construction and not paved or not designated to be paved. Grade surface at uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil as specified in Section 02911 - Topsoil and apply hydromulch according to requirements of Section 02921 - Hydromulch Seeding.
- E. Provide sodding in areas of residential land use over surface of ground disturbed during construction and not paved or not designated to be paved. Grade surface at uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil per Section 02911 - Topsoil. Sod disturbed areas in accordance with Section 02922 - Sodding.

3.9 POST-INSTALLATION CLEANING AND TELEVISION INSPECTION

- A. Prior to final acceptance of newly constructed gravity sanitary sewers, perform cleaning and closed circuit television inspection. Post installation television inspection shall be performed in accordance with Document 02558 – Cleaning and Television Inspection.
- B. Provide TV inspection reports and video submittals in accordance with Document 02558 – Cleaning and Television Inspection for each line segment submitted.
- C. Upon completion of video review, Contractor will be notified regarding final acceptance of sewer segment.

END OF SECTION

Section 02533

ACCEPTANCE TESTING FOR SANITARY SEWERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Acceptance testing of sanitary sewers including:
 - 1. Visual inspection of sewer pipes.
 - 2. Mandrel testing for flexible sewer pipes.
 - 3. Leakage testing of sewer pipes.
 - 4. Leakage testing of manholes.
 - 5. Smoke testing of point repairs.
 - 6. Television and Video Inspection.
- B. All tests listed in this Section are not necessarily required on this Project. Required tests are named in other Sections which refer to this Section for testing criteria and procedures.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for acceptance testing under this Section. Include payment in unit price for work requiring acceptance testing.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 828 - Standard Test Method for Low Pressure Air Test of Vitrified Clay Pipe Lines.

- B. ASTM C 924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
- C. ASTM D 3034 - Standard Specification for Type PSM Polyethylene (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- D. ASTM F 794 - Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- E. ASTM F 1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air.
- F. ASTM C 1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity flow sanitary sewers are required to have straight alignment and uniform grade between manholes.
- B. Flexible pipe, including "semi-rigid" pipe, is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of line segment but prior to final acceptance using standard mandrel to verify that installed pipe is within specified deflection tolerances.
- C. Must meet Texas Commission on Environmental Quality (TCEQ) Testing Requirements Chapter-217-57.

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Test Plan: Before testing begins and in adequate time to obtain approval through submittal process, prepare and submit test plan for approval by Engineer. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from Drawings and Specifications.
- C. Test Reports: Submit test reports for each test on each segment of sanitary sewer.

1.6 GRAVITY SANITARY SEWER QUALITY ASSURANCE

- A. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.
- B. Provide testing reports and video tape of television inspection as directed by Engineer.

- C. Upon completion of tape reviews by Engineer, Contractor will be notified regarding final acceptance of sewer segment.

1.7 SEQUENCING AND SCHEDULING

- A. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at onetime.
- B. Coordinate testing schedules with Engineer. Perform testing under observation of Engineer.

PART 2 PRODUCTS

2.1 DEFLECTION MANDREL

- A. Mandrel Sizing. Rigid mandrel shall have outside diameter (O.D.) equal to 95 percent of inside diameter (I.D.) of pipe. Inside diameter of pipe, for purpose of determining outside diameter of mandrel, shall be average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and average inside diameter for I.D. controlled pipe, dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
- B. Mandrel Design. Rigid mandrel shall be constructed of metal or rigid plastic material that can withstand 200 psi without being deformed. Mandrel shall have nine or more "runners" or "legs" as long as total number of legs is odd number. Barrel section of mandrel shall have length of at least 75 percent of inside diameter of pipe. Rigid mandrel shall not have adjustable or collapsible legs which would allow reduction in mandrel diameter during testing. Provide and use proving ring for modifying each size mandrel.
- C. Proving Ring. Furnish "proving ring" with each mandrel. Fabricate ring of 1/2-inch-thick, 3-inch-wide bar steel to diameter 0.02 inches larger than approved mandrel diameter.
- D. Mandrel Dimensions (5 percent allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02533-5, Pipe vs. Mandrel Diameter, at end of this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in table may be used when approved by Engineer.

2.2 EXFILTRATION TEST

- A. Water Meter: Obtain transient water meter from Authority for use when water for testing will be taken from Authority system. Conform to Authority requirements for water meter use.

B. Test Equipment:

1. Pipe plugs.
2. Pipe risers where manhole cone is less than 2 feet above highest point in pipe or service lead.

2.3 INFILTRATION TEST

A. Test Equipment:

1. Calibrated 90 degree V-notch weir.
2. Pipe plugs.

2.4 LOW PRESSURE AIR TEST

A. Minimum Requirement for Equipment:

1. Control panel
2. Low-pressure air supply connected to control panel.
3. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.
4. Air hoses from control panel to:
 - a. Air supply.
 - b. Pneumatic plugs.
 - c. Sealed line for pressuring.
 - d. Sealed line for monitoring internal pressure.

- B. Testing Pneumatic Plugs: Place pneumatic plug in each end of length of pipe on ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable when they remain in place against test pressure without external aids.

2.5 GROUNDWATER DETERMINATION

- A. Equipment: Pipe probe or small diameter casing for ground water elevation

determination.

2.6 SMOKE TESTING

A. Equipment:

1. Pneumatic plugs.
2. Smoke generator as supplied by Superior Signal Company, or approved equal.
3. Blowers producing 2500 scfm minimum.

PART 3 EXECUTION

3.1 PREPARATION

- A. Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure meters, pipe probe, calibrated weirs, or any other device necessary for proper testing and inspection.
- B. Determine selection of test methods and pressures for gravity sanitary sewers based on ground water elevation. Determine ground water elevation using equipment and procedures conforming to Section 01578 - Control of Ground Water and Surface Water.

3.2 VISUAL INSPECTION OF GRAVITY SANITARY SEWERS

- A. Check pipe alignment visually by flashing light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re- lay or replace pipe segment.

3.3 MANDREL TESTING FOR GRAVITY SANITARY SEWERS

- A. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D 3034. Perform testing no sooner than 30 days after backfilling of line segment, but prior to final acceptance testing of line segment.
- B. Pull approved mandrel by hand through sewer sections. Replace any section of sewer not passing mandrel. Mandrel testing is not required for stubs.
- C. Retest repaired or replaced sewer sections.

3.4 LEAKAGE TESTING FOR GRAVITY COLLECTION SYSTEM PIPES

- A. For a collection system pipe that will transport wastewater by gravity flow, test gravity sanitary sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.
- B. Compensating for Ground Water Pressure:
 - 1. Where ground water exists, install pipe nipple at same time sewer line is placed. Use 1/2-inch capped pipe nipple approximately 10 inches long. Make installation through manhole wall on top of sewer line where line enters manhole.
 - 2. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect clear plastic tube to nipple. Support tube vertically and allow water to rise in tube. After water stops rising, measure height in feet of water over invert of pipe. Divide this height by 2.3 feet/psi to determine ground water pressure to be used in line testing.
- C. Exfiltration test:
 - 1. Determine ground water elevation.
 - 2. Plug sewer in downstream manhole.
 - 3. Plug incoming pipes in upstream manhole.
 - 4. Install riser pipe in outgoing pipe of upstream manhole when highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.
 - 5. Fill sewer pipe and manhole or pipe riser, when used, with water to point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.
 - 6. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to Table 02533-1 at end of this Section.
- D. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).
 - 1. Determine ground water elevation.

2. Plug incoming pipes in upstream manhole.
 3. Insert calibrated 90 degree V-notch weir in pipe on downstream manhole.
 4. Allow water to rise and flow over weir until it stabilizes.
- E. Low Air Pressure Test: When using this test conform to ASTM C 828, ASTM C 924, or ASTM F 1417, as applicable, with holding time not less than that listed in Table 02533-2.
1. Low Pressure Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter. Refer to charts 02533-2 and 02533-3.
 2. Lines 36-inch average inside diameter and larger shall be tested at each joint. Minimum time allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during joint test shall be 10 seconds, regardless of pipe size.
- F. Retest: Repair and retest any section of pipe which fails to meet requirements.

3.5 TEST CRITERIA TABLES

- A. Exfiltration and Infiltration Water Tests: Refer to Table 02533-1, Water Test Allowable Leakage, at end of this Section.
- B. Low Pressure Air Test:
1. Times in Table 02533-2, Time Allowed for Pressure Loss from 3.5 psig to 2.5 psig, at end of this Section, are based on equation from Texas Commission on Environmental Quality (TCEQ) Design Criteria 217.57

$T = 0.0850(D)(K)/(Q)$		
where:	T =	time for pressure to drop 1.0 pounds per square inch gauge in seconds
	K =	0.000419 DL, but not less than 1.0
	D =	average inside diameter in inches
	L =	length of line of same pipe size in feet
	Q =	rate of loss, 0.0015 ft ³ /min./sq. ft. internal surface

2. Since K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as given in Table 02533-3, Minimum Testing Times for Low Pressure Air Test.

Notes:

1. When two sizes of pipe are involved, compute time by ratio of lengths involved.
2. Lines with 27-inch average inside diameter and larger may be air tested at each joint.
3. Lines with average inside diameter greater than 36 inches must be air tested for leakage at each joint.
4. If joint test is used, perform visual inspection of joint immediately after testing.
5. For joint test, pipe is to be pressurized to 3.5 psi greater than pressure exerted by groundwater above pipe. Once pressure has stabilized, minimum times allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

3.6 LEAKAGE TESTING FOR MANHOLES

- A. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.
- B. Plug influent and effluent lines, including service lines, with suitably-sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged when lines entering manhole have not been backfilled.
- C. Vacuum testing:
 2. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to recommended maximum inflation pressure; do not over-inflate.
 3. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for time period specified in Table 02533-4, Vacuum Test Time Table.
 4. A manhole passes the test if after 2.0 minutes and with all valves closed,

the vacuum is at least 9.0 inches of mercury (Hg).

D. Perform hydrostatic exfiltration testing as follows:

1. Seal wastewater lines coming into manhole with internal pipe plug. Then fill manhole with water and maintain it full for at least one hour.
2. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.
3. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.7 SMOKE TEST PROCEDURES FOR POINT REPAIRS

A. Application: Perform smoke test to:

1. Locate points of line failure for point repair.
2. Determine when point repairs are properly made.
3. Determine when service connections have been reconnected to rehabilitated sewer.
4. Check integrity of connections to newly replaced service taps to liners and to existing private service connections.

B. Limitations: Do not backfill service taps until completion of this test. Test only those taps in single manhole section at one time. Keep number of open excavations to minimum.

C. Preparation: Prior to smoke testing, give written notices to area residents no fewer than 2 days, nor more than 7 days, prior to proposed testing. Also give notice to City of Houston Police and Fire Departments or local fire and constable services as appropriate, 24 hours prior to actual smoke testing.

D. Isolate Section: Isolate manhole section to be tested from adjacent manhole sections to keep smoke localized. Temporarily seal annular space at manhole for sliplined sections.

E. Smoke Introduction:

1. Operate equipment according to manufacturer's recommendation and as approved by Engineer.

2. Conduct test by forcing smoke from smoke generators through sanitary sewer main and service connections. Operate smoke generators for minimum of 5 minutes.
 3. Introduce smoke into upstream and downstream manhole as appropriate. Monitor tap/connection for smoke leaks. Note sources of leaks.
- F. Repair and Retest: Repair and replace taps or connections noted as leaking and then retest. Taps and connections may be left exposed in only one manhole section at time. When repair or replacement, testing or retesting, and backfilling of excavation is not completed within one work day, properly barricade and cover each excavation as approved by Engineer.
- G. Service Connections: On houses where smoke does not issue from plumbing vent stacks to confirm reconnection of sewer service to newly installed liner pipe, perform dye test to confirm reconnection. Introduce dye into service line through plumbing fixture inside structure or sewer cleanout immediately outside structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms reconnection.
- 3.8 TELEVISION AND VIDEO INSPECTION PROCEDURE
- A. Refer to Document 02588- Cleaning and Television Inspection

Table 02533-1
WATER TEST ALLOWABLE
LEAKAGE

DIAMETER OF RISER OR STACK IN INCHES	VOLUME PER INCH OF DEPTH		ALLOWANCE LEAKAGE*	
	INCH	VOLUME (GALLONS)	PIPE SIZE IN INCHES	GAL./MINUTE PER 100 FT.
1	0.7854	0.0034	6	0.0039
2	3.1416	0.0136	8	0.0053
2.5	4.9087	0.0212	13	0.0066
3	7.0686	0.0306	12	0.0079
4	12.5664	0.0306	15	0.0099
5	19.6350	0.0544	18	0.0118
6	28.2743	0.1224	21	0.0138
8	50.2655	0.2176	24	0.0158
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1" diameter.			Equivalent to 50 gallons per inch of inside diameter per mile per 24 hours.	

* Allowable leakage rate must not exceed 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within 25-year flood plain.

Table 02533-2
ACCEPTANCE TESTING FOR
SANITARY SEWERS

TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG														
Pipe Dia. (in)	Min. Time (min: sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:56	15:12
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.3690	35:37	53:25	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

Table 02533-3
MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST

PIPE DIAMETER (INCHES)	MINIMUM TIME (SECOND)	LENGTH FOR MINIMUM TIME (FEET)	TIME FOR LONGER LENGTH (SECONDS/FT)
6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1020	133	7.693
21	1190	114	10.471
24	1360	100	13.676
27	1530	88	17.309
30	1700	80	21.369
33	1870	72	25.856

Table 02533-4
VACUUM TEST
TIME TABLE

DEPTH IN FEET	TIME IN SECONDS BY PIPE DIAMETER		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0
*Add T times for each additional 2-foot depth. (The values listed above have been extrapolated from ASTM C 1244)			

Table 02533-5
PIPE vs. MANDREL DIAMETER

Material and Wall Construction	Nominal Size (Inches)	Average I.D. (Inches)	Minimum Mandrel Diameter (Inches)
PVC-Solid (SDR 26)	6	5.764	5.476
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35)	12	11.737	11.150
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC-Truss	8	7.750	7.363
	10	9.750	9.263
	12	11.790	11.201
	15	14.770	14.032
PVC-Profile (ASTM F 794)	12	11.740	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
	48	47.500	45.125
HDPE-Profile	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600

WEST HARRIS COUNTY
REGIONAL WATER AUTHORITY

ACCEPTANCE TESTING
FOR SANITARY SEWERS

	54	54.000	51.300
	60	60.000	57.000
Fiberglass (Class SN 46)	12	12.85	11.822
	18	18.66	17.727
	20	20.68	19.646
	24	24.72	23.484
	30	30.68	29.146
	36	36.74	34.903
	42	42.70	40.565
	48	48.76	46.322
	54	54.82	52.079
	60	60.38	57.361

END OF SECTION

Section 02534

SANITARY SEWER SERVICE CONNECTIONS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Installation of service stubs in sanitary sewers serving areas where sanitary sewer service did not previously exist.
- B. Reconnection of existing service connections along parallel, replacement, or rehabilitated sanitary sewers.
- C. Installation of sanitary sewer service stubs, within street right-of-way, terminating with a clean-out and a plug at the right-of-way to allow for future connection of a single service, on at a double-wye fitting plugged at both to allow for future connection to two services.

1.2 DEFINITIONS

- A. Sanitary Sewer Service Connection: Piping and fittings installed for sanitary sewer service, including wye or tee fitting at sewer main, service lateral connection to wye or tee fitting at sewer main, stack (if required), service lateral piping to property or ROW line, and service lateral plug (if required). Refer to details on the Drawings.
- B. Stack: Vertical piping installed from sewer main for service connections to deep sewers. Refer to details on the Drawings.
- C. Service Lateral: Service piping from sewer main to property or ROW line. Refer to details on the Drawings.
- D. Cleanout: Vertical piping and fittings from service lateral to surface grade, including removable threaded pipe plug, precast concrete valve box and casting installed at property or ROW line. Refer to details on the Drawings.

1.3 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for sanitary sewer service connections with stacks located within 5 feet of sanitary sewer main centerline is on unit price basis for each connection. Payment will be made for each service connection installed

complete in place and in accordance with applicable details, including full-bodied tee or wye fitting with 6-inch branch, 6-inch 45° fitting, 6-inch service lateral piping, couplings, adapters, fittings, service lateral plug if required, disconnecting existing service, reconnecting new service, excavation, backfill, and testing.

2. Payment for sanitary sewer service connections without stacks located within 5 feet of sanitary sewer main is on unit price basis for each connection. Payment will be made for each service connection installed complete in place and in accordance with applicable details, including full-bodied tee or wye fitting with 6-inch branch, 6-inch 45° fitting, 6-inch service lateral piping, couplings, adapters, fittings, service lateral plug if required, disconnecting existing service, reconnecting new service, excavation, backfill and testing.
3. Payment for service laterals beyond 5 feet from the cleanout installed at the property or ROW line shall be paid as follows:
 - a. Payment for service laterals beyond 5 feet from the cleanout installed at the property or ROW line shall be paid on a linear foot basis. Measurement shall be taken along the centerline of the pipe. Payment will be made for each linear foot of pipe installed beyond 5 feet from the cleanout, complete in place, including excavation, shoring, bedding, backfill, and accessories. Auger pipe for service laterals will be paid as provided in Section 02448 – Pipe and Casing Augering.
 - b. Payment for standard 6-inch clean-out assembly on service lateral for a single or double future service connection installed at end of service lateral is on a unit price basis for each assembly and shall include all portions of the service lateral and service connection with clean-out installed within 5 feet of the property or ROW line. Payment will be made for each cleanout assembly installed, complete in place, including excavation, fittings, offsets, removable threaded plug, pipe sections, precast concrete valve box, valve box casting, bedding, backfill, and testing.
4. Pay estimates for progress payments will be made as measured above according to following schedule:
 - a. An estimate for 95 percent payment will be authorized when service connection is completely installed and backfilled.
 - b. An estimate for 100 percent payment will be authorized when service connection has been tested as specified in Section 02733 - Acceptance Testing for Sanitary Sewers.
5. One or more connections discharging into common point are considered one

service connection. Contractor shall not add service reconnections without approval of Engineer. Engineer may require connections to be relocated to avoid having more than two service connections per reconnection.

6. Protruding service lateral piping which must be removed to allow liner insertion shall be paid as service connections when connected to the liner. If abandoned, they will be paid as abandoned connections.
 7. Payment for abandonment of service connections is on unit price basis for each abandoned service connection. No separate payment will be made for abandonment of service connection unless excavation is required. No separate payment will be made for excavation of sanitary sewer services within new or replacement sewer trench.
 8. No separate payment will be made for removal of existing sanitary sewer service stubs. Include payment in unit price for Section 02534 - Sanitary Sewer Service Connections.
 9. No separate payment will be made for abandoned service connection when the service connection to be abandoned is within 4 feet of active connection. Payment for only one abandoned service connection will be allowed when second abandoned connection is within 4 feet of first.
 10. If faulty remote cut is later corrected using procedures specified for reconnection by excavation, only one reconnection will be allowed for payment.
 11. Sanitary Sewer Cleanout on Service Lateral shall be provided in accordance with detail provided. Payment is on per each basis as indicated in the Bid Form.
 12. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.4 REFERENCES

- A. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes

Using Flexible Elastomeric Seals.

- D. ASTM F 477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.5 PERFORMANCE REQUIREMENTS

- A. Accurately locate in field all proposed service stubs along new sanitary sewermain.
- B. Accurately locate in field existing service connections and proposed service stubs along alignment of new parallel or replacement sewer main.

1.6 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for each pipe product, fitting, coupling, adapter, and pipe saddle.
- C. Show reconnected services on record drawings. Give exact distance from each service connection to nearest downstream manhole.

Submit Post-installation television inspection videos in accordance with Document 02558 – Cleaning and Television Inspection.

PART 2 PRODUCTS

2.1 PVC SERVICE CONNECTIONS

- A. Use PVC sewer pipe of 4-inch through 10-inch diameter, conforming to ASTM D 1784 and ASTM D 3034, with cell classification of 12454. SDR (ratio of diameter to wall thickness) shall be 26 for pipe 10 inches in diameter or less.
- B. PVC pipe shall be gasket jointed with gasket conforming to ASTM D 3212.
- C. Provide service connection pipe in sizes shown on Drawings. For reconnection of existing services, select service lateral pipe diameter to match existing service lateral diameter. Reconnections to rehabilitated sanitary sewer mains shall be limited to following maximum service connection diameters:

Sewer Diameter	Maximum Service Connection Diameter
8" or less	4"
10" or greater	6"

- D. Subject to above limits, provide 6-inch service connection when more than one service discharges into single pipe.
- E. Connect service lateral pipes to parallel or replacement sewer mains with prefabricated, full-bodied tee or wye fittings conforming to specifications for sewer main pipe material as specified in other Sections for sewers up to 18 inches in diameter.
- F. Where sewers are installed using pipe augering or tunneling, or where sewer is greater than 18 inches in diameter, use three-piece service connection adapter tee conforming to ASTM C-923 to connect service lateral to sewer main.

2.2 SERVICE CONNECTION SADDLES

- A. Use pipe saddles only on rehabilitated sanitary sewer mains.
- B. Supply one-piece prefabricated saddle, either polyethylene or PVC, with neoprene gasket to accomplish complete seal at connection to sewer liner pipe. Use saddle fabricated to fit outside diameter of sewer liner pipe saddle shall be attached to sewer liner pipe with two stainless steel band clamps.
- C. Use 1/2-inch stainless steel band clamps for securing saddles to sewer liner pipe.

2.3 COUPLINGS AND ADAPTERS

- A. For connections between new PVC sewers and existing service laterals (4, 6, or 8-inch diameter), use flexible adapter coupling consisting of neoprene gasket, stainless steel shear rings with 1/2-inch stainless steel band clamps, and two nut and bolt clamps. For connections that are 10- inches or over, use neoprene gasket, with stainless steel shear band, and two stainless steel nut and bolt or T-Bolt clamps. Thermalized plastics are not allowed. Refer to approved couplings and adaptors.
 - 1. Product characteristics, meet ASTM C1173 and requirements for neoprene rubber and metallic components.
 - 2. Shear Band: ½ inch 300 series stainless steel shear band with two molded on worm gear clamps (ASTM A240)
 - 3. Clamps: 300 Series nut and bolt clamp band fabricated from AISI Type 316 stainless steel (ASTM A240)
- B. For connections between new PVC sewer and new service laterals, conform to the requirements of 2.1E use approved rubber-gasket adapter coupling conforming to requirements of 2.3A.

- C. Coupling and adaptor components shall be in accordance with following requirements:
1. Neoprene Rubber. 100% rubber. Thermalized plastics are not allowed.
 - a. Compressive Strength/ Tensile Strength, psi min (ASTM D412 Die C, ASTM D638). Initial value: 1000 min. Value after 112 days: 1000 min
 - b. Elongation at break, % (ASTM D412, ASTM D638). Initial value: 200 Value after 112 days: 200
 - c. Shore Durometer, Type A, point change max (ASTM D2240). Initial value (1 sec. reading, min): 60. Value point change max: 15
 - d. Compression Set -- Chemical exposures, % max (ASTM D395 Method B). Initial Value: 20 max. Value after exposure: 20 max
 - e. Compression Set -- Bacteriological, unconditioned surface dry, % max (ASTM D395 Method B): Initial value 20. Value after 112 day: 20
 - f. Water Absorption, % max (ASTM D570). Initial value: 4. Value after 112 days: % max ≥ 4
 - g. Aged Tensile (psi) -- Tensile strength (after exposure to 300 psi (2100 kPa) oxygen at $158^{\circ} \pm 1.8^{\circ}\text{F}$ [$70^{\circ} \pm 1^{\circ}\text{C}$] for 96 hours), % of initial, min (ASTM D572). Initial: 70 min. After accelerated aging: 70 min.
 - h. Aged Elongation -- Elongation at break (after exposure to 300 psi (2100 kPa) oxygen at $158^{\circ} \pm 1.8^{\circ}\text{F}$ [$70^{\circ} \pm 1^{\circ}\text{C}$] for 96 hours), % of initial, min. (ASTM D572). Initial value: 70 min. Test after accelerated aging: 70 min.
 - i. Ozone resistance (after exposure to 100 pphm ozone for 50 hours at $104^{\circ} \pm 2^{\circ}\text{F}$ [$40^{\circ} \pm 1^{\circ}\text{C}$]), (ASTM D518, procedure C, and ASTM D1149). Initial value: No cracking. After exposure: No cracking
 - j. Weight Change, % max. (approx. specimen size 1.0 x 3.0 x 0.1 inch) (25 x 75 x 2.5mm), (ASTM D543): value before and after exposure ± 1.5 max
 2. Stainless Steel components 300 series. (ASTM A240).
 3. Components can be factory fabricated or mechanically molded

2.4 STACKS

- A. Provide vertical stacks for service connections wherever crown of sewer is 8 feet or more below finished grade.
- B. Construct stacks of same material as sanitary sewer and as shown on Drawings.
- C. Provide stacks of same nominal diameter as service laterals.

2.5 PLUGS AND CAPS

- A. Seal upstream end of unconnected sewer service laterals with rubber gasket plugs or caps of same pipe type and size.

2.6. THREE-PIECE SERVICE CONNECTION TEE ADAPTER

- A. The service connection tee adapter is comprised of three components: PVC hub, stainless steel band, and rubber boot.
- B. PVC hub and rubber boot shall be engineered to accept the wall thickness and internal radius of the pipe. The PVC hub and rubber boot shall protrude no more than ½-inch into the sewer main.
- C. The PVC hub shall be in accordance with ASTM D-3034.
- D. The rubber boot shall be in accordance with ASTM F 477.
- E. The tee adapter shall be sized to accept 4-inch or 6-inch service lines, as required.
- F. The tee adapter shall only be used when approved by the Engineer.

2.7 SANITARY SEWER STANDARD CLEANOUT ON SERVICE LATERAL:

- A. Where directed, the contractor shall remove (if existing) and install new sanitary sewer cleanout. This shall include: frame and cover, molded polyethylene, four-way cleanout, 12-inch Ultra-Rib PVC or SDR35 PVC riser pipe, 2-foot square concrete pad, cement stabilized sand backfill, and all labor, equipment, and site restoration.
- B. The standard frame and cover shall be cast iron, embossed with “Sewer Cleanout” “City of Houston”.
- C. The molded polyethylene, four-way cleanout shall be the “wastewater access chamber” as manufactured by Uponor ETI Co. or approved equal.
- D. Riser pipe shall be 12” Ultra-Rib PVC or SDR35 PVC.

- E. Provide sealing material between pipe riser and cleanout cover frame that is a hydrophilic elastic sealant, or approved equal.

2.8 SANITARY SEWER 4-INCH OR 6-INCH CLEANOUT ON SERVICE LATERAL

- A. Where directed, the contractor shall remove (if existing) and install new sanitary sewer cleanout. This shall include: 4-inch or 6-inch removable threaded countersunk plug, 4-inch or 6-inch SDR 35 PVC riser pipe with 45 degree bend and wye, 3-RT Valve Box MFG by Old Castle Precast Inc or approved equal, and all labor, equipment, and site restoration. Payment made will be made at the unit price set in the Bid Form. Where service lateral to an abandoned house is encountered, install 4-inch or 6-inch plug for future house connection. All work shall be performed in accordance with Standard Cleanout Detail on Service Lateral Detail.

PART 3 EXECUTION

3.1 PERFORMANCE REQUIREMENTS

- A. Provide minimum of 72 hours notice to customers whose sanitary sewer service will potentially be interrupted.
- B. Accurately field locate service connections, whether in service or not, along rehabilitated sanitary sewer main. For parallel and replacement sewers, service connections may be located as pipe laying progresses from downstream to upstream.
- C. Properly disconnect existing service connections from sewer and reconnect to rehabilitated liner, as described in this Section.
- D. Reconnect service connections, including those that go to unoccupied or abandoned buildings or to vacant lots, unless directed otherwise by Project Manager. Install a stack and plug the reconnection where the service is to a vacant lot or location where a structure has been demolished, unless directed otherwise by Engineer.
- E. Complete reconnection of service lines within 24 hours after cured-in-place liner installation and within 72 hours after disconnection for installation of sliplining, or parallel or replacement sanitary sewer mains.
- F. Reconnect services on cured-in-place liner at 10 feet depth or less by excavation method. Engineer reserves the right to require service connections by excavation when remote cut service connection damages lines.
- G. Reconnection by excavation method shall include stack and fittings and required pipe length to reconnect service line.
- H. Connect services 8-inches in diameter and larger to sewer by construction of

manhole. Refer to appropriate Section on manholes for construction and payment.

- I. Flexible couplings and adapters shall be used for connecting existing or new service laterals to new PVC service lateral pipe and for pipe transitions. When used for pipe transitions, flexible couplings or adapters shall be eccentric reducers and shall be installed in the horizontal position or on a horizontal slope less than 1:1 or less than a 45° angle (such that the flowline across the pipe size transition shall remain straight; no upset). The Contractor shall properly cut the ends of the two PVC pipes joined by the flexible coupling or adapter such that they do not extend into the transition area of the reducer. Pipe size transitions from existing or new services to new PVC pipe shall not be made in the vertical position (in a stack or riser). Flexible couplings or adapters shall not be installed in the vertical position or on a slope greater than 1:1 or greater than a 45° angle.

3.2 PROTECTION

- A. Provide barricades, warning lights, and signs for excavations created for service connections. Conform to requirements of Section 01504 - Temporary Facilities and Controls.
- B. Do not allow sand, debris, or runoff to enter sewer system.

3.3 PREPARATION

- A. Determine existing sewer locations and number of existing service connections from closed-circuit television (CCTV) inspection tapes or from field survey. Accurately field locate existing service connections, whether in service or not. Use existing service locations to connect or reconnect service lines or liner.
- B. For rehabilitated sanitary sewer mains, allow liner to normalize to ambient temperature and recover from imposed stretch. For cured-in-place liners, verify that liner is completely cured.
- C. For new parallel and replacement sanitary sewer mains, complete testing and acceptance of downstream sewers as applicable. Provide for compliance with requirements of Paragraph 3. 1E.

3.4 EXCAVATION AND BACKFILL

- A. Excavate in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Perform work in accordance with OSHA standards. Employ Trench Safety System as specified in Section 02260 - Trench Safety System for excavations requiring trench safety.
- C. Install and operate necessary ground water and surface water control measures in

accordance with requirements of Section 01578 - Control of Ground Water and Surface Water.

- D. Determine locations where limited access, buildings or structure preclude use of mechanical excavation equipment. Obtain approval from Engineer for hand excavation.
- E. When the excavation shows that a service line is not connected, abandon the service reconnection and backfill the excavation.

3.5 RECONNECTION BY EXCAVATION METHOD

A. SADDLE METHOD

1. Remove a portion of the existing sanitary sewer main or carrier pipe to expose the liner pipe. Provide sufficient working space for installing a pre-fabricated pipe saddle.
2. Carefully cut a hole in the liner pipe to accept the protrusion on the underside of the saddle. Length of protrusion shall be equal to the wall thickness of the liner pipe.
3. Apply an approximately ½-inch diameter bead of uncured, 100% pure silicone caulk (siliconized caulk will not be allowed), GE or approved equal, to the surface of the gasket that contacts the bottom of the saddle. A ½-inch bead of silicone caulk shall also be placed around the tapped hole in the polyethylene, PVC, or cured-in-place pipe. The beads of caulk should be placed approximately in the center of the gasket and, on the pipe, in the center of the area covered by the gasket. The saddle shall be installed and secured while the silicone caulk is uniformly fluid and pliable, not hardened or rubbery and with no hardened, rubbery areas or nodules. Adequate quantities of silicone caulk should be applied to allow it to flow or be extruded into any corrugations in the gasket surface and into any irregularities (scratches or gouges) in the surface of the polyethylene, PVC, or cured-in-place pipe.
4. Install the saddle with gasket using stainless steel bands on each side of the saddle. Tighten the bands to produce a watertight seal between the saddle and the liner pipe.

B. THREE-PIECE SERVICE CONNECTION TEE ADAPTER METHOD

1. Remove a portion of the existing sanitary sewer main or carrier pipe to expose the liner pipe. Provide sufficient working space to install three-piece service connection.

2. Precisely cut a circular hole, per the manufactures recommendations, in the liner pipe that will form a tight fit between the liner pipe PVC stub and rubber boot.
3. Install the rubber boot into the cored hole, making sure the boot is properly oriented to the mainline. Lubricate the rubber boot with a special solution provided by the three piece service connection manufacturer. Make sure the upper and lower ribs of the rubber boot are correctly seated against the inside and outside diameter of the liner pipe.
4. Insert the PVC hub into the rubber boot, per manufacturer's recommended instructions. Place stainless steel band around the top of the rubber boot and tighten to form a watertight seal.

C. SERVICE LATERAL CONNECTIONS TO SADDLES OR THREE-PIECE
SERVICE CONNECTION TEE ADAPTERS

1. Remove and replace cracked, offset or leaking service lateral pipe up to 8 feet (measured horizontally) from the center line of the new liner.
2. Make connections between liner and existing service line using PVC sewer pipe and approved couplings/fittings using stainless steel bands to construct new stacks and/or service laterals.
3. Test all service connections by smoke testing the sewer main and connections before backfilling.
4. Encase the entire service connection is cement stabilized sand or crushed stone. Place a minimum of 6 inches below and 12 inches above and on each side of the service lateral pipe and pipe connection.

3.6 RECONNECTION BY REMOTE METHOD

- A. Make service reconnections using remote-operated cutting tools on cured-in-place liners at depth greater than 10 feet.
- B. Employ method and equipment that restore service connection capacity to not less than 90 percent of original capacity.
- C. Immediately open missed connections and repair holes drilled in error using method approved by Engineer.

3.7 RECONNECTION ON PARALLEL OR REPLACEMENT SEWERS

- A. Install a full-bodied tee or wye fitting on the new sanitary sewer main for each service connection.

- B. Remove and replace cracked, offset or leaking service lateral pipe for up to 5 feet, measured horizontally, from centerline of sanitary sewer main.
- C. Make up connection between main and existing service lateral using PVC sewer pipe and approved couplings, as shown on Drawings.
- D. Test service connections before backfilling.
- E. Embed service connection and service lateral as specified for sanitary sewer main as shown on Drawings. Place and compact trench zone backfill in compliance with Section 02317 - Excavation and Backfill for Utilities.

3.8 INSTALLATION OF NEW SERVICE CONNECTIONS

- A. Install service connections on sanitary sewer main for each service connection shown on the drawings. Provide length of service lateral pipe required to allow sufficient room for standard 6-inch clean-out assembly in accordance with detail. Install plug(s) on the upstream end(s) of service lateral pipe (s) as needed.
- B. Test service connections before backfilling.
- C. Embed service connection and service lateral as specified for sanitary sewer main, and as shown on Drawings. Place and compact trench zone backfill in compliance with Section 02317 - Excavation and Backfill for Utilities. Install a minimum 2-foot length of magnetic locating tape along the centerline of the service lateral and 9 inches to 12 inches above crown of service lateral pipe.

3.9 TESTING

- A. Test service connections and service lateral piping. Follow applicable procedures given in Section 02533 - Acceptance Testing for Sanitary Sewers to perform smoke testing to confirm connections.
- B. Perform post installation CCTV inspection as specified in Section 02558 - Cleaning and Television Inspection to show locations of service connections.

3.10 CLEANUP

- A. Backfill excavation as specified in Section 02317 - Excavation and Backfill for Utilities.
- B. Replace pavement or sidewalks removed or damaged by excavation in accordance with Section 02951 - Pavement Repair and Resurfacing. In unpaved areas, bring surface to grade and slope surrounding excavation. Replace minimum of 4 inches of topsoil and seed according to requirements of Section 02921 - Hydro-mulch

Seeding.

END OF SECTION

Section 02558

CLEANING AND TELEVISION INSPECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cleaning sewer lines to remove solids, roots, soil, sand, pieces of broken pipe, bricks, grease, grit from sewer lines and manholes and other debris, thus improving flow and facilitating television inspection for sewer evaluation. Cleaning includes initial manhole wall washing by high-pressure water jet.
- B. Television inspecting the line to obtain quality video and Television Inspection Reports upon which the Authority can make decisions regarding needed sewer rehabilitation.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

- 1. Survey Normal Cleaning Equipment: Measurement for cleaning sanitary sewer mains with normal cleaning equipment is on a linear-foot basis. The Contract unit price for cleaning with normal equipment is full payment for sewer line actually cleaned and accepted. Cleaning using normal cleaning equipment includes:
 - a. Charges for transient water meter setup and water usage;
 - b. Collection, removal, transportation and legal disposal of liquid wastes, soil, sand and other debris for lines less than or equal to 48-inches in diameter;
 - c. Locating, exposing and opening manholes on sewers to be cleaned;
 - d. Initial manhole wall washing with high-pressure water. Payment for additional cleaning and scrubbing of manhole walls which may be required for manhole rehabilitation is included in the unit price for manhole wall sealing as specified in Section 02555 - Manhole Rehabilitation; and
 - e. Reconstruction of manholes dismantled for cleaning equipment access, and repair of damage caused by dismantling or cleaning equipment.
- 2. Cleaning Using Mechanical Cleaning Equipment: Measurement for cleaning sanitary sewer mains with mechanical cleaning equipment is on a linear-foot basis for the quantity approved by the Engineer. The Contract unit price for cleaning sanitary sewer mains with mechanical cleaning equipment is paid in addition to the unit price for

-
- cleaning using normal cleaning equipment. Mechanical cleaning is limited to locations approved by the Engineer on a case-by-case basis after normal cleaning methods have failed to produce satisfactory results, as determined by viewing video.
- a. Mechanical cleaning prior to normal cleaning does not relieve the Contractor of the responsibility for fully cleaning the pipe with normal cleaning equipment.
 - b. Reconstruction of manholes dismantled for cleaning equipment access, and repair of damage caused by dismantling or cleaning equipment.
 - c. Unit price for cleaning using mechanical equipment is compensation in full for all collection, removal, transportation and legal disposal of liquid wastes, soil, sand and debris regardless of quantity of material.
3. Survey Television Inspection: Measurement of survey television inspection for pipe segments selected by the Engineer is on a linear-foot basis from centerline to centerline of manholes. Payment for survey television inspection is made for the actual lengths of television inspection footage, as measured in the field at grade, as submitted for evaluation prior to final recommendations of sewer rehabilitation method. No separate payment will be made for the following:
- a. Poor or unacceptable-quality video (hazy, unclear images will not qualify for payment);
 - b. Re-recording of any segment without prior approval of the Project Manager;
 - c. Portions of sanitary sewer not recorded (no payment will be made for length of sewer through which the camera could not pass);
 - d. Reverse setups required to bracket an obstruction; or
 - e. Sewer flow control.
4. Payment for video inspection by floating camera shall be made based on bid item for TV Inspection of appropriate line size.
5. Pre-Installation Cleaning:
- a. No separate payment will be made for pre-installation cleaning using normal cleaning equipment for pipes less than or equal to 48-inches in diameter. Include cost for pre-installation cleaning in cost of line work for which the rehabilitation effort is performed. If a line is inspected and, in the opinion of the Engineer, found to require no rehabilitation work, payment of cleaning will be made on the basis of survey normal cleaning.

- b. Payment will be made for Pre-installation cleaning of pipes greater than 48- inches in diameter.
- 6. Pre-Installation Television Inspection: No separate payment will be made for pre-installation television inspection, except for lines inspected but not rehabilitated. Include cost for pre-installation television inspection in the cost of line work for which the rehabilitation effort is performed. If a line is inspected and, in the opinion of the Engineer, found to require no rehabilitation work, Contractor will be paid for pre-installation television inspection on the basis of survey television inspection.
- 7. Post-Installation Television Inspection: No separate payment will be made for post-installation television inspection. Include cost for post-installation television inspection in the cost of line work for which the rehabilitation is performed. The post-installation television inspection policy allows payment for work based on field-measured lengths indicated on the inspector's daily reports, but still requires the Contractor to submit a post-installation video within one calendar month after segment completion. If no video is received within that period, credit for the previously paid line segment will automatically be deducted from pay estimates in following months until the required video is submitted.
- 8. Footage paid for survey cleaning, under some circumstances, may exceed the footage paid for survey television inspection, as approved by the Engineer.
- 9. If the Contractor is unable to complete the TV inspection of a mainline section after performing a reverse setup (i.e., obstructions are encountered from both the upstream and downstream manhole that prevents the passage of the camera), the Contractor shall be paid for television inspection of the actual footage of pipe successfully televised, if the TV inspection video and report are of acceptable quality.
- 10. Payment for cleaning of siphon shall be by pipe diameter, all depths, and on a linear foot basis measured along the centerline of the siphon pipe and from centerline of upstream manhole or junction box to centerline of downstream manhole or junction box. Cleaning of siphon shall include cleaning of both the upstream and downstream manholes or junction boxes unless they are included in the cleaning of the adjacent upstream and/or downstream gravity sewer section. Both hydraulic cleaning and mechanical cleaning equipment may be employed to clean a siphon using the cleaning of siphon pay item. No separate payment for mechanical cleaning.
- 12. Payment for TV inspection of siphon shall be by pipe diameter, all depths, and on a linear foot basis measured along the centerline of the siphon pipe from centerline of the upstream manhole or junction box to centerline of downstream manhole or junction box. Payment for TV inspection of siphon shall include any dewatering, excluding bypass pumping, required to provide a clear picture of the pipe in the depressed portion of the siphon, with camera lens centered in the pipe

and above water surface level such that pipe defects and debris may be visually detected.

13. Payment for the collection, removal, transportation and legal disposal of liquid wastes, soil, sand and other debris removed from sanitary sewer or siphon greater than or equal to 48-inches in diameter while performing cleaning shall be by cubic yard. Measurement shall be by properly executed waste manifest for roll-off container. The container shall be available on site as needed. The container shall not be loaded with material other than debris from the sanitary sewer system, shall not contain excessive free water, and shall be filled to the appropriate capacity for transportation.

- B. Stipulated Price (Lump Sum): If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 DEFINITIONS

- A. Normal Cleaning Equipment: Cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sewer balls, kites, and other approved equipment in conjunction with hand-winch devices and gas or electric rod-propelled devices. Variable-pressure water nozzles (3000 psi) are considered normal cleaning equipment.
- B. Mechanical Cleaning Equipment: Buckets, scrapers, scooters, porcupines, kites, heavy-duty brushes, metal pigs and other debris-removing equipment and accessories used in conjunction with approved power winching machines. High-to very-high-pressure water nozzles (10,000 psi) are considered mechanical cleaning equipment.
- C. Survey Cleaning and Television Inspection: Video inspection of existing sanitary sewers to evaluate lines and determine whether conditions exist which would require line rehabilitation.
- D. Pre-Installation Television Inspection: Video inspection by Contractor of sewer lines designated for rehabilitation to confirm cleaning, location of service connections and constructability of line rehabilitation according to Drawings and Specifications.
- E. Post-Installation Television Inspection: Video inspection to determine whether rehabilitation of a sanitary sewer has been completed according to Drawings and Specifications.
- F. Television Inspection Report: A report that is submitted in pdf format for each line segment using NASSCO PACP codes.
- G. Siphon or Inverted Siphon: A depressed section of gravity sanitary sewer that allows a graded or sloped sewer to convey flow across a conflicting underground utility or open drainage channel by passing under it.

1.4 PERFORMANCE REQUIREMENTS

- A. Clean designated sanitary sewers and manholes using mechanical, hydraulically-propelled or high-velocity sewer cleaning equipment. Select cleaning processes which will remove grease, soil, sand, silt, solids, rags and debris from each sewer segment and associated manholes.

1.5 SUBMITTALS

- A. Comply with Section 01330 - Submittal Procedures.
- B. Submit equipment manufacturer's operational manuals and guidelines to the Project Manager for review. Strictly follow such instructions unless otherwise directed by the Engineer.
- C. Submit a list of lawful disposal sites proposed for dumping debris from cleaning operations.
- D. Submit and maintain Liquid Waste Manifests conforming to Harris County or City of Houston Health and Human Services requirements. Send the owner's and regulator's copies of the completed manifests to the Engineer within 24 hours after disposal of waste materials.
- E. The Contractor shall provide the Authority with the sewer video (including audio), a hard copy report and an electronic report in pdf format for the inspections for each line segment. The electronic report and video shall be named by line segment. The sewer video shall be MPEG4 format. The Contractor shall utilize the latest NASSCO PACP codes at the time of the Contract notice to proceed. Prior to commencing the work the NASSCO PACP codes to be utilized shall be submitted. All work on the contract shall follow the same codes. Inspection Software must be NASSCO PACP Certified and proof of certification of Software shall be submitted prior to commencing the work. Contractor shall be current on NASSCO training. All electronic data shall be submitted in MS Access. Any variation from the requirements shall be subject to approval by the Engineer. Submittal of the CCTV videos and the reports for review can be submitted through a data storage device, such as a flash drive, or through Contractor's FTP site and will be available for download. An email of the information availability and phone calls to the Inspector, Senior Inspector and/or specific contact shall be made.
- F. At the end of the contract, the Contractor shall submit a hard drive including all videos and reports for the entire contract.
- G. The digital information shall contain files which store each line segment as a unique digital record.

1.6 QUALITY ASSURANCE

- A. Qualifications: Use experienced personnel to operate cleaning equipment and devices.

- B. Acceptance of sewer cleaning work is subject to successful completion of the television inspection. If inspection shows solids, sand, grease, grit or other debris remaining in the line, the cleaning is considered unsatisfactory. Repeat cleaning and video inspection of the sewer line until cleaning is acceptable by the Engineer.
- C. Unable to Penetrate: If the Contractor is unable to penetrate a line during cleaning or CTV inspection, the Contractor will call the Houston Service Center at 311 (inside city limits) or (713) 837-0311 (outside city limits) within 24 hours of the event.
- D. The work shall comply with current NASSCO standards.

PART 2 P R O D U C T S

2.1 CLEANING EQUIPMENT

- A. Select cleaning equipment and methods based on the condition of the sanitary sewer mains at the time work begins. More than one method or type of equipment may be required on a single project or at a single location.
- B. When requested by the Project Manager, demonstrate at the performance capabilities of cleaning equipment and methods proposed for use on the project. If results obtained by demonstration are not satisfactory, provide other equipment that will clean the sewer line.
- C. For high-velocity cleaning use a water jet capable of producing a minimum volume of 50 gpm with a pressure of 1500 psi at the pump. Install a gauge to indicate working pressure on the discharge of high-pressure water pumps. In addition to conventional nozzles, use a nozzle which directs the cleaning force to the bottom of the pipe for sewers 18-inches and larger.
- D. When hydraulic or high-velocity cleaning equipment is used, install a suitable sand trap, weir, dam or suction device in the downstream manhole so that solids and debris are trapped for removal.
- E. When approved by the Engineer, both hydraulic cleaning and mechanical cleaning equipment (including pumps) may be employed to clean a siphon.

2.2 CLEANING ACCESSORIES

- A. When an additional quantity of water from the public water supply is needed to meet the cleaning requirements of the equipment and the sewer, obtain transient water meters from the Authority for installation on trucks or at fire hydrants.
- B. Obtain prior written approval when using a fire hydrant located in the Downtown Houston area as required by Houston Fire Department Regulations. However, prior

written approval from the Department of Public Works and Engineering is not needed to use fire hydrants located elsewhere within the City of Houston.

- C. All cleaning equipment must be equipped with backflow preventers to prevent contamination to the public water supply.
- D. If approved by the Engineer, pneumatic or hydraulically powered “knockers” or chain flails may be used to remove heavy tuberculation in cast iron siphon pipes.

2.3 VIDEO EQUIPMENT

- A. Video Equipment: Select and use video equipment that will produce color videos.
- B. Pipe Inspection Camera: Produce a video using a pan-and-tilt radial-viewing pipe inspection camera that pans ± 275 degrees and rotates 360 degrees. Use a camera with an accurate footage counter, which displays on the monitor the exact distance of the camera from the centerline of the starting manhole. Use a camera with a camera height adjustment so that the camera lens is always centered at one-half the inside diameter, or higher in the pipe being inspected. Provide a lighting system that allows the features and condition of the pipe to be clearly seen. A reflector in front of the camera may be required to enhance lighting in dark or large diameter pipe.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin cleaning until both upstream and downstream manholes have been checked for flow monitors and other mechanical devices. Refer to Section 02555 - Manhole Rehabilitation.

3.2 PREPARATION

- A. Take precautions to protect sanitary sewer mains and manholes from damage that might be inflicted by the improper selection of cleaning processes or improper use of equipment. When using hydraulically-propelled devices take precautions to ensure that the water pressure created does not cause damage to or flooding of public or private property. Do not surcharge any sanitary sewer to an elevation that could cause overflow of sewage into area waterways, homes or buildings, or onto the surface.
- B. Do not use or obstruct fire hydrants when there is a fire in the area. Remove water meters, fittings and piping from fire hydrants at the end of each working day.
- C. Exercise care to prevent contamination of the potable water system. Use an appropriately sized backflow preventer as required by the City of Houston Water Department when drawing water from a public hydrant.

- D. Where possible, use the flow of wastewater present in the sanitary sewer main to provide fluid for hydraulic cleaning devices.

3.3 CLEANING

- A. Conserve Water. Do not waste water from the public water supply through poor connections, hydrants left open, or any other cause.
- B. Collapsible Dams: Use collapsible dams for hydraulically-propelled devices which require a head of water to operate. Dam shall be easily collapsible to prevent damage to the sewer, public property and private property.
- C. High Velocity Cleaning: Operate high-velocity cleaning equipment so that the pressurized nozzle moves continuously. Turn off or reduce the flow to the nozzle to prevent damage to the line any time the nozzle becomes stationary.
- D. Mechanical Cleaning: In addition to normal cleaning equipment, perform mechanical cleaning when required and approved using equipment and accessories as defined in this Section.
- E. Debris Disposal: Remove sludge, soil, sand, rocks, grease, roots and other solid or semi-solid material resulting from the cleaning operation at the downstream manhole of the section being cleaned. Passing debris from any sewer section to any other sewer section is not allowed. Load debris from the manholes into an enclosed container permitted by the Houston Health Department for liquid waste hauling. Remove solids and semi-solids resulting from cleaning operations from the site and dispose them lawfully at the end of each work day. Do not accumulate debris, liquid waste, or sludge on the site except in totally enclosed containers approved by the Engineer.
- F. Disposal Sites: Dispose of waste at a lawfully-permitted disposal site using a transporter having a valid City Liquid Waste Transporter Permit.

3.4 TELEVISION INSPECTION

- A. Immediately after cleaning, video inspect the sanitary sewer line to document the condition of the line and to locate existing service connections. Notify the Engineer 24 hours in advance of any television inspection so that the Engineer may observe inspection operations.
- B. Perform television inspection of sanitary sewers as follows:
 - 1. Perform a survey television inspection on sanitary sewers within the boundary of the project, as directed by the Engineer. After reviewing survey video the Engineer will determine which sanitary sewers will be rehabilitated or need additional work.

2. Perform pre-installation television inspection immediately after cleaning and before line rehabilitation work. Pre-installation video inspection is not required for sewer lines designated to be removed and replaced. Verify that the line is clean and ready to accept the line rehabilitation. Prepare Television Inspection Report forms. Maintain copies of all video reports for reference by the Engineer for the duration of the project.
 3. Videos shall pan all manholes showing benches, walls, annular spaces, and debris removal. Camera operator shall slowly pan each service connection, clamped joint and pipe material transition from one material to another. Complete and submit a Television Inspection Report for every sewer segment video submitted to the Engineer.
 4. Perform post-installation television inspection to confirm completion of rehabilitation work, including removal and replacement. Verify that rehabilitation work conforms to the requirements of the Drawings and Specifications. Provide a video showing the completed work including the condition of restored service connections. Prepare and submit Television Inspection Report forms providing the location of service connections along with the location of any discrepancies. Post-installation video of completed manholes may be substituted for photographic documentation, as described in Section 02555 – Manhole Rehabilitation. Manhole work, including benches, inverts and pipe penetrations into manhole, should be complete prior to post-installation video work.
 5. Contractor shall make actual measurement of pipe inside diameter and record measurement to nearest tenth of one inch as “pipe size” on “Television Inspection Report” and on “Video Header”.
- C. Survey television inspection videos 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 video, unless specifically allowed by the Engineer.
- D. Videos shall include audio.

3.5 FLOW CONTROL

- A. Perform survey television inspection on one manhole section at a time. Adequately control the flow in the section being inspected. Do not exceed the depth of wastewater flow shown below:

<u>Pipe Diameter (Inches)</u>	<u>Depth of Flow (Percentage of Pipe Diameter)</u>
6 - 10	10
12 - 24	15
Over 24	20

If during survey television inspection of a manhole section, the wastewater flow depth exceeds the maximum allowable, reduce the flow depth to an acceptable level by performing the survey television inspection during minimum flow hours, by diversion pumping or by pulling a camera with swab, high-velocity jet nozzle or other acceptable dewatering device. Video inspections made while floating the camera is not acceptable unless approved by the Engineer.

- B. Minimize flow in the line while performing pre-installation television inspection. Divert the normal flow as specified in Section 01506 - Diversion Pumping, and clean the line to be inspected.
- C. No flow is allowed in the line while performing post-installation video inspection.

3.6 PASSAGE OF VIDEO CAMERA

- A. Do not pull or propel the video camera through the line at a speed greater than 30 feet per minute.
- B. If during survey television inspection of a manhole section, the camera is unable to pass an obstruction even though flow is unobstructed, televise the manhole section from the other direction (reverse setup) in order to obtain a complete video of the line. Whenever such a condition arises, notify the Engineer to determine whether an obstruction removal or point repair is necessary. If a point repair is authorized, repair the pipe at the designated location and then re-televise the manhole section to verify completion of the point repair, unless waived by the Engineer.
 - 1. When the camera is being pulled from the other direction in order to survey on either side of an obstruction and a second obstruction or repair location is encountered away from the first obstruction, notify the Engineer and request a review of the video. The Engineer may direct the Contractor to make one or both repairs. No downtime shall be allowed.
 - 2. Once point repairs are completed, re-inspect the manhole section.
 - 3. The Authority makes no guarantee that the sanitary sewer designated for survey television after cleaning is clear for the passage of the camera set-up. Select the appropriate equipment, tools and methods for securing safe passage of the camera.
- C. During pre-installation television inspection, camera passage should show the line is ready for rehabilitation. Report to the Engineer any variations between previous reported (existing data) conditions and actual conditions encountered.

- D. For post-installation television inspection, exercise the full capabilities of the camera equipment to document the completion of the rehabilitation work and the conformance of the work to the Drawings and Specifications. Provide a full 360-degree view of pipe, joints and service connections.

3.7 TELEVISION INSPECTION REPORT

- A. Provide a television inspection report in pdf format for each line segment using NASSCO PACP codes. The electronic report shall be named by line segment.

3.8 FIELD QUALITY CONTROL

- A. Do not under any circumstances, allow sewage or solids removed in the cleaning process to be released onto streets or into ditches, catch basins, cleanouts, storm drains, or sanitary or storm sewer manholes.
- B. Acceptance of sewer cleaning work is subject to successful completion of the television inspection. If the television inspection shows solids, soil, sand, grease, grit, or other debris remaining in the line, cleaning will be considered unsatisfactory. Repeat cleaning and inspection of the line segment until cleaning is judged satisfactory by the Engineer.

3.9 MANHOLE REPAIR

- A. Repair manholes dismantled or damaged during the cleaning process, and replace manhole frames and covers damaged during the cleaning process.

END OF SECTION

Section 02558

CLEANING AND TELEVISION INSPECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cleaning sewer lines to remove solids, roots, soil, sand, pieces of broken pipe, bricks, grease, grit from sewer lines and manholes and other debris, thus improving flow and facilitating television inspection for sewer evaluation. Cleaning includes initial manhole wall washing by high-pressure water jet.
- B. Television inspecting the line to obtain quality video and Television Inspection Reports upon which the Authority can make decisions regarding needed sewer rehabilitation.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

- 1. Survey Normal Cleaning Equipment: Measurement for cleaning sanitary sewer mains with normal cleaning equipment is on a linear-foot basis. The Contract unit price for cleaning with normal equipment is full payment for sewer line actually cleaned and accepted. Cleaning using normal cleaning equipment includes:
 - a. Charges for transient water meter setup and water usage;
 - b. Collection, removal, transportation and legal disposal of liquid wastes, soil, sand and other debris for lines less than or equal to 48-inches in diameter;
 - c. Locating, exposing and opening manholes on sewers to be cleaned;
 - d. Initial manhole wall washing with high-pressure water. Payment for additional cleaning and scrubbing of manhole walls which may be required for manhole rehabilitation is included in the unit price for manhole wall sealing as specified in Section 02555 - Manhole Rehabilitation; and
 - e. Reconstruction of manholes dismantled for cleaning equipment access, and repair of damage caused by dismantling or cleaning equipment.
- 2. Cleaning Using Mechanical Cleaning Equipment: Measurement for cleaning sanitary sewer mains with mechanical cleaning equipment is on a linear-foot

basis for the quantity approved by the Engineer. The Contract unit price for cleaning sanitary sewer mains with mechanical cleaning equipment is paid in addition to the unit price for cleaning using normal cleaning equipment. Mechanical cleaning is limited to locations approved by the Engineer on a case-by-case basis after normal cleaning methods have failed to produce satisfactory results, as determined by viewing video.

- a. Mechanical cleaning prior to normal cleaning does not relieve the Contractor of the responsibility for fully cleaning the pipe with normal cleaning equipment.
 - b. Reconstruction of manholes dismantled for cleaning equipment access, and repair of damage caused by dismantling or cleaning equipment.
 - c. Unit price for cleaning using mechanical equipment is compensation in full for all collection, removal, transportation and legal disposal of liquid wastes, soil, sand and debris regardless of quantity of material.
3. Survey Television Inspection: Measurement of survey television inspection for pipe segments selected by the Engineer is on a linear-foot basis from centerline to centerline of manholes. Payment for survey television inspection is made for the actual lengths of television inspection footage, as measured in the field at grade, as submitted for evaluation prior to final recommendations of sewer rehabilitation method. No separate payment will be made for the following:
 - a. Poor or unacceptable-quality video (hazy, unclear images will not qualify for payment);
 - b. Re-recording of any segment without prior approval of the Project Manager;
 - c. Portions of sanitary sewer not recorded (no payment will be made for length of sewer through which the camera could not pass);
 - d. Reverse setups required to bracket an obstruction; or
 - e. Sewer flow control.
4. Payment for video inspection by floating camera shall be made based on bid item for TV Inspection of appropriate line size.
5. Pre-Installation Cleaning:
 - a. No separate payment will be made for pre-installation cleaning using normal cleaning equipment for pipes less than or equal to 48-inches in diameter. Include cost for pre-installation cleaning in cost of line work for

- which the rehabilitation effort is performed. If a line is inspected and, in the opinion of the Engineer, found to require no rehabilitation work, payment of cleaning will be made on the basis of survey normal cleaning.
- b. Payment will be made for Pre-installation cleaning of pipes greater than 48-inches in diameter.
6. Pre-Installation Television Inspection: No separate payment will be made for pre- installation television inspection, except for lines inspected but not rehabilitated. Include cost for pre-installation television inspection in the cost of line work for which the rehabilitation effort is performed. If a line is inspected and, in the opinion of the Engineer, found to require no rehabilitation work, Contractor will be paid for pre-installation television inspection on the basis of survey television inspection.
7. Post-Installation Television Inspection: No separate payment will be made for post-installation television inspection. Include cost for post-installation television inspection in the cost of line work for which the rehabilitation is performed. The post-installation television inspection policy allows payment for work based on field-measured lengths indicated on the inspector's daily reports, but still requires the Contractor to submit a post-installation video within one calendar month after segment completion. If no video is received within that period, credit for the previously paid line segment will automatically be deducted from pay estimates in following months until the required video is submitted.
8. Footage paid for survey cleaning, under some circumstances, may exceed the footage paid for survey television inspection, as approved by the Engineer.
9. If the Contractor is unable to complete the TV inspection of a mainline section after performing a reverse setup (i.e., obstructions are encountered from both the upstream and downstream manhole that prevents the passage of the camera), the Contractor shall be paid for television inspection of the actual footage of pipe successfully televised, if the TV inspection video and report are of acceptable quality.

Payment for cleaning of siphon shall be by pipe diameter, all depths, and on a linear foot basis measured along the centerline of the siphon pipe and from centerline of upstream manhole or junction box to centerline of downstream manhole or junction box. Cleaning of siphon shall include cleaning of both upstream and downstream manholes or junction boxes unless they are included in the cleaning of the adjacent upstream and/or downstream gravity sewer section. Both hydraulic cleaning and mechanical cleaning equipment may be employed to clean a siphon using the cleaning of siphon pay item. No separate payment for mechanical cleaning.

10. Payment for TV inspection of siphon shall be by pipe diameter, all depths, and

on a linear foot basis measured along the centerline of the siphon pipe from centerline of the upstream manhole or junction box to centerline of downstream manhole or junction box. Payment for TV inspection of siphon shall include any dewatering, excluding bypass pumping, required to provide a clear picture of the pipe in the depressed portion of the siphon, with camera lens centered in the pipe and above water surface level such that pipe defects and debris may be visually detected.

12. Payment for the collection, removal, transportation and legal disposal of liquid wastes, soil, sand and other debris removed from sanitary sewer or siphon greater than or equal to 48-inches in diameter while performing cleaning shall be by cubic yard. Measurement shall be by properly executed waste manifest for roll-off container. The container shall be available on site as needed. The container shall not be loaded with material other than debris from the sanitary sewer system, shall not contain excessive free water, and shall be filled to the appropriate capacity for transportation.

- B. Stipulated Price (Lump Sum): If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 DEFINITIONS

- A. Normal Cleaning Equipment: Cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sewer balls, kites, and other approved equipment in conjunction with hand-winch devices and gas or electric rod-propelled devices. Variable-pressure water nozzles (3000 psi) are considered normal cleaning equipment.
- B. Mechanical Cleaning Equipment: Buckets, scrapers, scooters, porcupines, kites, heavy-duty brushes, metal pigs and other debris-removing equipment and accessories used in conjunction with approved power winching machines. High-to very-high-pressure water nozzles (10,000 psi) are considered mechanical cleaning equipment.
- C. Survey Cleaning and Television Inspection: Video inspection of existing sanitary sewers to evaluate lines and determine whether conditions exist which would require line rehabilitation.
- D. Pre-Installation Television Inspection: Video inspection by Contractor of sewer lines designated for rehabilitation to confirm cleaning, location of service connections and constructability of line rehabilitation according to Drawings and Specifications.
- E. Post-Installation Television Inspection: Video inspection to determine whether rehabilitation of a sanitary sewer has been completed according to Drawings and Specifications.
- F. Television Inspection Report: A report that is submitted in pdf format for each line segment using NASSCO PACP codes.

- G. Siphon or Inverted Siphon: A depressed section of gravity sanitary sewer that allows a graded or sloped sewer to convey flow across a conflicting underground utility or open drainage channel by passing under it.

1.4 PERFORMANCE REQUIREMENTS

- A. Clean designated sanitary sewers and manholes using mechanical, hydraulically-propelled or high-velocity sewer cleaning equipment. Select cleaning processes which will remove grease, soil, sand, silt, solids, rags and debris from each sewer segment and associated manholes.

1.5 SUBMITTALS

- A. Comply with Section 01330 - Submittal Procedures.
- B. Submit equipment manufacturer's operational manuals and guidelines to the Project Manager for review. Strictly follow such instructions unless otherwise directed by the Engineer.
- C. Submit a list of lawful disposal sites proposed for dumping debris from cleaning operations.
- D. Submit and maintain Liquid Waste Manifests conforming to Harris County or City of Houston Health and Human Services requirements. Send the owner's and regulator's copies of the completed manifests to the Engineer within 24 hours after disposal of waste materials.
- E. The Contractor shall provide the Authority with the sewer video (including audio), a hard copy report and an electronic report in pdf format for the inspections for each line segment. The electronic report and video shall be named by line segment. The sewer video shall be MPEG4 format. The Contractor shall utilize the latest NASSCO PACP codes at the time of the Contract notice to proceed. Prior to commencing the work the NASSCO PACP codes to be utilized shall be submitted. All work on the contract shall follow the same codes. Inspection Software must be NASSCO PACP Certified and proof of certification of Software shall be submitted prior to commencing the work. Contractor shall be current on NASSCO training. All electronic data shall be submitted in MS Access. Any variation from the requirements shall be subject to approval by the Engineer. Submittal of the CCTV videos and the reports for review can be submitted through a data storage device, such as a flash drive, or through Contractor's FTP site and will be available for download. An email of the information availability and phone calls to the Inspector, Senior Inspector and/or specific contact shall be made.
- F. At the end of the contract, the Contractor shall submit a hard drive including all videos and reports for the entire contract.

- G. The digital information shall contain files which store each line segment as a unique digital record.

1.6 QUALITY ASSURANCE

- A. Qualifications: Use experienced personnel to operate cleaning equipment and devices.
- B. Acceptance of sewer cleaning work is subject to successful completion of the television inspection. If inspection shows solids, sand, grease, grit or other debris remaining in the line, the cleaning is considered unsatisfactory. Repeat cleaning and video inspection of the sewer line until cleaning is acceptable by the Engineer.
- C. Unable to Penetrate: If the Contractor is unable to penetrate a line during cleaning or CTV inspection, the Contractor will call the Houston Service Center at 311 (inside city limits) or (713) 837-0311 (outside city limits) within 24 hours of the event.
- D. The work shall comply with current NASSCO standards.

PART 2 PRODUCTS

2.1 CLEANING EQUIPMENT

- A. Select cleaning equipment and methods based on the condition of the sanitary sewer mains at the time work begins. More than one method or type of equipment may be required on a single project or at a single location.
- B. When requested by the Project Manager, demonstrate the performance capabilities of cleaning equipment and methods proposed for use on the project. If results obtained by demonstration are not satisfactory, provide other equipment that will clean the sewer line.
- C. For high-velocity cleaning use a water jet capable of producing a minimum volume of 50 gpm with a pressure of 1500 psi at the pump. Install a gauge to indicate working pressure on the discharge of high-pressure water pumps. In addition to conventional nozzles, use a nozzle which directs the cleaning force to the bottom of the pipe for sewers 18-inches and larger.
- D. When hydraulic or high-velocity cleaning equipment is used, install a suitable sand trap, weir, dam or suction device in the downstream manhole so that solids and debris are trapped for removal.
- E. When approved by the Engineer, both hydraulic cleaning and mechanical cleaning equipment (including pumps) may be employed to clean a siphon.

2.2 CLEANING ACCESSORIES

- A. When an additional quantity of water from the public water supply is needed to meet the cleaning requirements of the equipment and the sewer, obtain transient water meters from the water provider for installation on trucks or at fire hydrants.
- B. All cleaning equipment must be equipped with backflow preventers to prevent contamination to the public water supply.
- C. If approved by the Engineer, pneumatic or hydraulically powered “knockers” or chain flails may be used to remove heavy tuberculation in cast iron siphon pipes.

2.3 VIDEO EQUIPMENT

- A. Video Equipment: Select and use video equipment that will produce color videos.
- B. Pipe Inspection Camera: Produce a video using a pan-and-tilt radial-viewing pipe inspection camera that pans ± 275 degrees and rotates 360 degrees. Use a camera with an accurate footage counter, which displays on the monitor the exact distance of the camera from the centerline of the starting manhole. Use a camera with a camera height adjustment so that the camera lens is always centered at one-half the inside diameter, or higher in the pipe being inspected. Provide a lighting system that allows the features and condition of the pipe to be clearly seen. A reflector in front of the camera may be required to enhance lighting in dark or large diameter pipe.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin cleaning until both upstream and downstream manholes have been checked for flow monitors and other mechanical devices. Refer to Section 02555 - Manhole Rehabilitation.

3.2 PREPARATION

- A. Take precautions to protect sanitary sewer mains and manholes from damage that might be inflicted by the improper selection of cleaning processes or improper use of equipment. When using hydraulically-propelled devices take precautions to ensure that the water pressure created does not cause damage to or flooding of public or private property. Do not surcharge any sanitary sewer to an elevation that could cause overflow of sewage into area waterways, homes or buildings, or onto the surface.
- B. Do not use or obstruct fire hydrants when there is a fire in the area. Remove water meters, fittings and piping from fire hydrants at the end of each working day.
- C. Exercise care to prevent contamination of the potable water system. Use an appropriately sized backflow preventer as required by the City of Houston Water

Department or other provider when drawing water from a public hydrant.

- D. Where possible, use the flow of wastewater present in the sanitary sewer main to provide fluid for hydraulic cleaning devices.

3.3 CLEANING

- A. Conserve Water. Do not waste water from the public water supply through poor connections, hydrants left open, or any other cause.
- B. Collapsible Dams: Use collapsible dams for hydraulically-propelled devices which require a head of water to operate. Dam shall be easily collapsible to prevent damage to the sewer, public property and private property.
- C. High Velocity Cleaning: Operate high-velocity cleaning equipment so that the pressurized nozzle moves continuously. Turn off or reduce the flow to the nozzle to prevent damage to the line any time the nozzle becomes stationary.
- D. Mechanical Cleaning: In addition to normal cleaning equipment, perform mechanical cleaning when required and approved using equipment and accessories as defined in this Section.
- E. Debris Disposal: Remove sludge, soil, sand, rocks, grease, roots and other solid or semi-solid material resulting from the cleaning operation at the downstream manhole of the section being cleaned. Passing debris from any sewer section to any other sewer section is not allowed. Load debris from the manholes into an enclosed container permitted by the Houston Health Department for liquid waste hauling. Remove solids and semi-solids resulting from cleaning operations from the site and dispose them lawfully at the end of each work day. Do not accumulate debris, liquid waste, or sludge on the site except in totally enclosed containers approved by the Engineer.
- F. Disposal Sites: Dispose of waste at a lawfully-permitted disposal site using a transporter having a valid City Liquid Waste Transporter Permit.

3.4 TELEVISION INSPECTION

- A. Immediately after cleaning, video inspect the sanitary sewer line to document the condition of the line and to locate existing service connections. Notify the Engineer 24 hours in advance of any television inspection so that the Engineer may observe inspection operations.
- B. Perform television inspection of sanitary sewers as follows:
 - 1. Perform a survey television inspection on sanitary sewers within the boundary of the project, as directed by the Engineer. After reviewing survey video the Engineer will determine which sanitary sewers will be rehabilitated or need

additional work.

2. Perform pre-installation television inspection immediately after cleaning and before line rehabilitation work. Pre-installation video inspection is not required for sewer lines designated to be removed and replaced. Verify that the line is clean and ready to accept the line rehabilitation. Prepare Television Inspection Report forms. Maintain copies of all video reports for reference by the Engineer for the duration of the project.
 3. Videos shall pan all manholes showing benches, walls, annular spaces, and debris removal. Camera operator shall slowly pan each service connection, clamped joint and pipe material transition from one material to another. Complete and submit a Television Inspection Report for every sewer segment video submitted to the Engineer.
 4. Perform post-installation television inspection to confirm completion of rehabilitation work, including removal and replacement. Verify that rehabilitation work conforms to the requirements of the Drawings and Specifications. Provide a video showing the completed work including the condition of restored service connections. Prepare and submit Television Inspection Report forms providing the location of service connections along with the location of any discrepancies. Post-installation video of completed manholes may be substituted for photographic documentation, as described in Section 02555 – Manhole Rehabilitation. Manhole work, including benches, inverts and pipe penetrations into manhole, should be complete prior to post-installation video work.
 5. Contractor shall make actual measurement of pipe inside diameter and record measurement to nearest tenth of one inch as “pipe size” on “Television Inspection Report” and on “Video Header”.
- C. Survey television inspection videos 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 video, unless specifically allowed by the Engineer.
- D. Videos shall include audio.

3.5 FLOW CONTROL

- A. Perform survey television inspection on one manhole section at a time. Adequately control the flow in the section being inspected. Do not exceed the depth of wastewater flow shown below:

PIPE DIA. (INCHES)	DEPTH OF FLOW (PERCENTAGE OF PIPE DIA.)
6 – 10	10
12 – 24	15
Over 24	20

If during survey television inspection of a manhole section, the wastewater flow depth exceeds the maximum allowable, reduce the flow depth to an acceptable level by performing the survey television inspection during minimum flow hours, by diversion pumping or by pulling a camera with swab, high-velocity jet nozzle or other acceptable dewatering device. Video inspections made while floating the camera is not acceptable unless approved by the Engineer.

- B. Minimize flow in the line while performing pre-installation television inspection. Divert the normal flow as specified in Section 01506 - Diversion Pumping, and clean the line to be inspected.
- C. No flow is allowed in the line while performing post-installation video inspection.

3.6 PASSAGE OF VIDEO CAMERA

- A. Do not pull or propel the video camera through the line at a speed greater than 30 feet per minute.
- B. If during survey television inspection of a manhole section, the camera is unable to pass an obstruction even though flow is unobstructed, televise the manhole section from the other direction (reverse setup) in order to obtain a complete video of the line. Whenever such a condition arises, notify the Engineer to determine whether an obstruction removal or point repair is necessary. If a point repair is authorized, repair the pipe at the designated location and then re-televise the manhole section to verify completion of the point repair, unless waived by the Engineer.
 - 1. When the camera is being pulled from the other direction in order to survey on either side of an obstruction and a second obstruction or repair location is encountered away from the first obstruction, notify the Engineer and request a review of the video. The Engineer may direct the Contractor to make one or both repairs. No downtime shall be allowed.
 - 2. Once point repairs are completed, re-inspect the manhole section.
 - 3. The Authority makes no guarantee that the sanitary sewer designated for survey television after cleaning is clear for the passage of the camera set-up. Select the appropriate equipment, tools and methods for securing safe passage of the camera.

- C. During pre-installation television inspection, camera passage should show the line is ready for rehabilitation. Report to the Engineer any variations between previous reported (existing data) conditions and actual conditions encountered.
- D. For post-installation television inspection, exercise the full capabilities of the camera equipment to document the completion of the rehabilitation work and the conformance of the work to the Drawings and Specifications. Provide a full 360-degree view of pipe, joints and service connections.

3.7 TELEVISION INSPECTION REPORT

- A. Provide a television inspection report in pdf format for each line segment using NASSCO PACP codes. The electronic report shall be named by line segment.

3.8 FIELD QUALITY CONTROL

- A. Do not under any circumstances, allow sewage or solids removed in the cleaning process to be released onto streets or into ditches, catch basins, cleanouts, storm drains, or sanitary or storm sewer manholes.
- B. Acceptance of sewer cleaning work is subject to successful completion of the television inspection. If the television inspection shows solids, soil, sand, grease, grit, or other debris remaining in the line, cleaning will be considered unsatisfactory. Repeat cleaning and inspection of the line segment until cleaning is judged satisfactory by the Engineer.

3.9 MANHOLE REPAIR

- A. Repair manholes dismantled or damaged during the cleaning process, and replace manhole frames and covers damaged during the cleaning process.

END OF SECTION

Section 02611

REINFORCED CONCRETE PIPE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Reinforced concrete pipe for sanitary sewers and storm sewers.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. No separate payment will be made for reinforced concrete pipe under this Section. Include cost in unit price Work as specified in following Sections:
 - a. Section 02426 - Sewer Line in Tunnels.
 - b. Section 02531 - Gravity Sanitary Sewers.
 - c. Section 02631 - Storm Sewers.
- 2. Refer to Section 01270- Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- B. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- C. ASTM C 497 - Standard Test Method for Concrete Pipe, Manhole Sections, or Tile.
- D. ASTM C 506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe
- E. ASTM C 507 – Standard Specification for Reinforced Concrete Elliptical

Culverts, Storm Drains and Sewer Pipe

- F. ASTM C 655 - Standard Specification for Reinforced Concrete D-load Culvert, Storm Drain and Sewer Pipe.
- G. ASTM C 877 - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
- H. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants.
- I. ASTM C 1479 – Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
- J. ASTM C 1837 – Standard Specification for Production of Dry Cast Concrete Used for Manufacturing Pipe, Box, and Precast Structures.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit complete product data for pipe, fittings and gaskets for approval. Indicate conformance to appropriate reference standards.
- C. Submit manufacturer's certificate that concrete pipes meet applicable standards.
- D. For jacking pipe, submit drawings and data describing grouting port design and closure procedures when required by Section 02431 - Tunnel Grout, including liner repair, as applicable.

PART 2 P R O D U C T S

2.1 REINFORCED CONCRETE PIPE

- A. Conform circular reinforced concrete pipe to requirements of ASTM C 76, Class III. Conform to rubber gasket joints for sanitary sewers and storm sewers per ASTM C443 and tongue and groove joints for roadside ditch culverts with joints per ASTM C 990.
- B. Conform reinforced concrete arch pipe to requirements of ASTM C 506 for Class A-III. Joints shall conform to ASTM C 443 or tongue & groove joints shall conform to ASTM C 990 with external sealing bands conforming to ASTM C 877. For roadside ditch culverts only, external sealing bands are not required.
- C. Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to

requirements of ASTM C 507 for Class VE-III for vertical or Class HE-III for horizontal. Rubber gasket joints shall conform to ASTM C 443. Tongue & groove joints shall conform to ASTM C 990 with external sealing bands conforming to ASTM C 877. For roadside ditch culverts only, external sealing bands are not required.

- D. Conform reinforced concrete D-load pipe requirements of ASTM C 655.

2.2 GASKETS

- A. When no contaminant is identified, furnish joints per Paragraph 2.1
- B. Use the following gasket materials for pipes to be installed in potentially contaminated areas, especially where free product is found near elevation of proposed sewer:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants Other Contaminants	As recommended by pipe manufacturer, Engineer of the Record and approved by Authority Engineer prior to installation

2.3 LINERS FOR SANITARY SEWER PIPE

- A. Reinforced concrete pipe for sanitary sewers shall be PVC lined and conform to Section 02427 - Plastic Liner for Large Diameter Concrete Sewers and Structures.
- B. Reinforced concrete pipes to be installed in potentially contaminated areas shall have liners recommended by manufacturer as resistant to contaminants identified in Phase II Environmental Site Assessment Report.

2.4 SOURCE QUALITY CONTROL

- A. Representatives of Authority Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Conform to requirements of following Sections, as applicable:
1. Section 02448 - Pipe and Casing Augering for Sewers.
 2. Section 02531 - Gravity Sanitary Sewers.

- 3. Section 02631 - Storm Sewers.
- 4. Section 02441 - Micro-tunneling and Pipe-Jacked Tunnels.
- B. Install reinforced concrete pipe in accordance with ASTM C 1479 and manufacturer's recommendations.

END OF SECTION

Section 02612

PRECAST REINFORCED CONCRETE BOX SEWERS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Precast reinforced concrete box for storm sewers.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for precast reinforced concrete box sewer under this Section. Include payment in unit price for Sections 02631 - Storm Sewers.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 1577 – Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD.
- B. ASTM C 990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Flexible Joint Sealants
- C. ASTM C 1677 – Standard Specification for Joints for Concrete Box, Using Rubber Gaskets
- D. ASTM C 1675 – Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains and Sewers
- E. ASTM C 1837 – Specification for Production of Dry Cast Concrete for Manufacturing Pipe, Box and Precast Structures

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings and data on box sections, fittings, gaskets, and appurtenances for approval. Indicate conformance to reference standards.

PART 2 P R O D U C T S

2.1 PRECAST REINFORCED CONCRETE BOX SEWERS

- A. Conform to ASTM C-1577, as indicated on Drawings.
- B. Pipe and boxes shall be machine-made or cast by process which will provide for uniform placement of concrete in forms and compaction by mechanical devices to produce dense, structurally sound concrete.
- C. Box culverts may be supplied with a tongue and groove joint per ASTM C 990. Rubber gaskets per ASTM C 1677 may be used if indicated on drawings.

2.2 CONCRETE

- A. Conform to requirements ASTM C 1837.
- B. Use concrete mixed in central batch plant or other batching facility from which quality and uniformity of concrete can be assured. Transit-mixed concrete is not acceptable.

2.3 SOURCE QUALITY CONTROL

- A. Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

PART 3 E X E C U T I O N

3.1 BEDDING

- A. Bed box sections on foundation of firm and stable material accurately shaped to conform to their bases. Install bedding as specified in Section 02317 - Excavation and Backfill for Utilities. When required by Drawings, use special bedding material. When single-cell box sections are placed in parallel for multi-cell installation, place in conformance with details shown on Drawings.

3.2 PLACEMENT

- A. Carefully lower box sections to bottom of trench and lay accurately in line and

grade, with spigot or tongue end downstream entering bell or groove end to full depth and in such manner as not to drag foreign material into annular space.

3.3 JOINTING

- A. Join box sections together and match so that they will form continuous smooth and uniform invert.

3.4 BACKFILLING

- A. After box has been properly jointed and bedded, commence backfilling.
- B. Backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

Section 02613

BAR WRAPPED STEEL CYLINDER PIPE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Furnishing and installing new bar wrapped steel cylinder pipe and fittings for buried water lines for sizes 20 inches to 60 inches.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for bar wrapped steel cylinder pipe under this Section. Include cost in price for water lines.
 - 2. Maintain, on site, minimum of two 3-degree and two 5-degree grade angle adapters. Adapters are considered “extra unit price.” When used during construction, adapter will be paid at unit price.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AASHTO - Standard Specifications for Highway Bridges.
- B. AREMA - Manual of Railway Engineering, Volume II, Chapter 15.
- C. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- D. ASTM C 33 - Standard Specification for Concrete Aggregates.
- E. ASTM C 35 - Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.
- F. ASTM C 150 - Standard Specification for Portland Cement.

- G. ASTM C 497 - Standard Test Method for Concrete Pipe, Manhole Sections, or Tile, Testing.
- H. ASTM D 512 - Standard Test Methods for Chloride Ion in Water.
- I. ASTM C 1107 (CRD C-621) - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- J. ASTM D 1293 - Standard Test Methods for pH of Water.
- K. ASTM E 165 - Standard Test Methods for Dye Penetration.
- L. ASTM E 340 - Standard Test Method for Macroetching Metals and Alloys.
- M. ASTM E 709 - Standard Test Methods for Magnetic Particle Testing.
- N. ASTM E 1032 - Standard Test Methods for Radiographic Examination of Weldments.
- O. ANSI/AWS A3.0 - Standard Welding Terms and Definitions.
- P. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
- Q. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.
- R. AWWA C 301 - Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids.
- S. AWWA C 303 - Standard for Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type.
- T. AWWA C 304 - Standard for Design of Prestressed Concrete Cylinder Pipe.
- U. AWWA M 9 - Concrete Pressure Pipe.
- V. NSF 61 - Drinking Water System Components - Health Effects.
- W. SSPC SP 7 - Surface Preparation Specification No. 7 Brush Off Blast Cleaning.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings and certification signed and sealed by Professional Engineer registered in State of Texas showing following:

Manufacturer's pipe design calculations

1. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Engineer. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*PDF).
 2. Include hot tapping procedure.
 3. Submit certification from manufacturer that design was performed for project in accordance with requirements of this section.
- C. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit standard repair procedures that describe in detail shop and field work to be performed. Repair defects such as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, etc.
- D. Submit following within 45 days after manufacturing of pipe and fittings:
1. Steel:
 - a. Steel reports as required in AWWA C303, Section 5.2.5.
 - b. Results of other tests of steel reinforcement required in AWWA C303, Section 5.2.
 2. Test Results.
 - a. Hydrostatic testing, acid etching, magnetic particle and x-ray weld test reports as required.
 - b. Compressive strength (7 and 28 day) test results for each type of coating and lining mix design.
 3. Submit pipe manufacturer's certification that Bar Wrapped Steel Cylinder Pipe:
 - a. Cylinder assembly has been hydrostatically tested at factory.
 - b. Mortar coatings and linings were applied or allowed to cure at temperature above 32 degrees Fahrenheit.

- E. Submit following for nonshrink grout for special applications:
 - 1. Manufacturer's technical literature including specifications for mixing, placing, and curing grout.
 - 2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C 1107, Nonshrink Grout and requirements of this specification.
 - 3. Certification product is suitable for use in contact with potable water.
- F. Submit certification for welder and welding operator demonstrating their certification in accordance with AWWA C 206. Indicate certified procedures and position each welder is qualified to perform.
- G. Calibrate within last 12 months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by Engineer.

1.5 QUALITY CONTROL

- A. Manufacturer to have permanent quality control department and laboratory facility capable of performing inspection and testing required. Inspection procedures and manufacturing process are subject to inspection by Engineer. Perform manufacturer tests and inspections required by AWWA C 303 as modified by these Specifications. Correct nonconforming conditions.
 - 1. Cylinder and Joint Ring Assembly:
 - a. Review mill certifications for conformance to requirements of Specifications.
 - b. Perform physical testing of each heat of steel for conformance to applicable ASTM standards.
 - c. Inspect physical dimensions and overall condition of joint rings and cylinder/joint ring assembly to verify compliance with requirements of AWWA C 303. Maximum allowable thickness variation of cylinder shall not be less than determined thickness.
 - d. Test cylinder/joint ring weld for tensile strength. Test one specimen for each 500 cylinder/joint ring assemblies in addition to those tests required by AWWA C 301.

- e. Reject pipe with dented steel cylinders.
- 2. Bar Rod
 - a. Review mill certifications for conformance to requirements of Specifications.
 - b. Inspect rod spacing during placement on cylinder.
 - c. Test rod splices for each production run or minimum of once a week, whichever is less, for conformance with minimum strength criteria.
- 3. Pipe Lining Coating:
 - a. Review mill certificates for each load of cement for conformance to ASTM C 150.
 - b. Perform sieve analyses weekly for each source of coarse and fine aggregate for conformance to ASTM C 33.
 - c. Inspect kiln recorder charts daily to confirm proper curing environment.
 - d. Verify mortar thickness on each size of pipe to a tolerance of 1/16th of an inch of required thickness.
 - e. Perform absorption tests in accordance with ASTM C 497, Method A, on cured mortar samples taken from pipes.
 - f. Check mortar batch proportions, moisture content and slurry application rate. Check coating thickness over wire on each pipe.
 - g. Check physical integrity of cured mortar coating. Check cured mortar coating for soundness on every pipe in field in addition to manufacturing plant.
 - h. Reject pipe with cracks in mortar coating exceeding 0.01 inches wide.
- 4. Protective Coatings: Check daily application rate and resulting dry film thickness.
- B. Gaskets:
 - 1. Randomly test rubber cord for diameter, tensile strength, elongation, compression set, hardness, and specific gravity after oven aging on one out of 100 gaskets.

2. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

C. Weld Testing

1. Perform macroetching tests for complete penetration production welds on normal production weld tests. Complete joint penetration welds are defined in ANSI/AWS A3.0. Verify complete joint penetration by means of macroetch of joint weld cross section. Macroetch technique in accordance with ASTM E 340.
 2. Perform ultrasonic or x-ray testing of manual welds for fittings and special pipes. Perform dye penetration testing of manual lap welds for fittings and special pipes and for joint ring weld onto cylinder.
 3. Perform minimum of one set of weld test specimens in accordance with ANSI/AWS A3.0 on each size, grade and wall thickness at minimum of every 3,000 feet of pipe manufactured; but perform no less than one test per project by each welding machine and each operator.
- D. Cast four standard test cylinders each day for each 50 cubic yards of concrete mortar coating or portion thereof for each coating and lining mix design placed in day. Perform compressive strength test at 28 days. No cylinder test result shall be less than 80 percent of specified strength. Reject pipe that does not meet minimum strength requirements.
- E. Make available copy of Physical and Chemical testing reports for steel cylinders and provide reports at request of Engineer.
- F. Check physical dimensions of pipe and fittings: Physical dimensions to include at least pipe lengths, pipe I.D., pipe O.D. and bend angles.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Furnish pipe by same manufacturer. Do not ship over salt water.
- B. Provide bar wrapped steel cylinder pipe in conformance with AWWA C 303 and AWWA M 9, except as modified herein. Produce pipe cylinder to conform to AWWA C 303 except modify Section 4.5 to require that total cross-sectional area of bell ring plus cross-sectional area of bar reinforcement over bell ring exceed circumferential steel area in like length of barrel area by one-third.
- C. Use of pipe from inventory is permitted only if specifications and certifications are met. Provide testing records for such pipe.

- D. Do not use bar wrapped steel cylinder pipe in aerial crossings, exposed or other unburied areas.
- E. Pipe Manufacturer.
 - 1. Must have minimum of 5 years of manufacturer's pipe installations that have been in successful and continuous service.
 - 2. Must maintain on site or in plant minimum of four 22.5 bends per 10,000 linear feet of water line. Any combination of bends may be substituted at manufacturer's option (i.e. two 11.25 bends are equivalent to one 22.5 bend and shall be counted as one fitting). Must be capable of delivering bends to job site within 12 hours of notification. These fittings are in addition to any fittings called out on Drawing and must be available at all times.
- F. Pipe Design Conditions:
 - 1. Working pressure: 150 psi.
 - 2. Hydrostatic field test pressure: 150 psi.
 - 3. Maximum pressure due to surge: 225 psi.
 - 4. Minimum pressure due to surge: -14.7 psi (full vacuum).
 - 5. Unit weight of soil: 120 pcf minimum, unless otherwise specified.
 - 6. Minimum trench width: O.D. of pipe + 4 feet.
 - 7. Pipe and Fittings: Designed to withstand most critical simultaneous application of external loads including construction loads and internal pressures.
 - 8. Design: Design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading, AREA E-80 loads and depths of bury as indicated on Drawings. Design pipes with Marston's earth loads for transition width trench for all heights of cover.
 - a. Calculate moments and thrusts in wall based on earth load.
 - 9. Increase longitudinal steel area (cylinder thickness) to prevent cylinder stress from exceeding 40 percent of minimum yield point at rated working pressure and 67 percent of minimum yield point at rated maximum surge pressure where pipe and fittings are subjected to longitudinal stresses induced by restrained joints or thrust blocks.

10. Groundwater Level: Design for most critical ground water level condition.
11. Modulus of elasticity (E) = 30,000,000 psi.
12. Design stress due to working pressure to be no greater than 50 percent of minimum yield, and stress not to exceed 16,500 psi for mortar coated pipe.
13. Design stress due to maximum hydraulic surge pressure to be no greater than 75 percent of minimum yield, and stress not to exceed 24,750 psi for mortar coated pipe.
14. Modulus of soil reaction (E) < 1500 psi. If E > 1000 psi, do not use silty sand (SM) for embedment.
15. Deflection lag factor (DI) = 1.2.
16. Bedding constant (K) = 0.1.
17. Fully saturated soil conditions: hw = h = depth of cover above top of pipe.
18. Provide minimum inside clear diameter for tunnel liners or casing in accordance with Section 02425LD - Tunnel Excavation and Primary Liner.
19. Exclude structural benefits associated with primary liner in design of pipe in tunnel installations.
 - a. Design pipe and joints to carry loads including overburden and lateral earth pressures, subsurface soil and water loads, grouting, other conditions of service, thrust of jacks, and stresses anticipated during handling and construction loads during installation of pipe.
 - b. Do not use internal removable stiffeners for pipe in tunnel, unless approved by Engineer.
 - c. External welded stiffeners shall be permitted in design calculations for pipe, provided wall thickness is minimum of 1/2 inch. Minimum clearances specified between exterior pipe wall and tunnel liner applies to distance between outside diameter of external welded stiffener and tunnel liner.
20. Design pipe for transmitting potable water, unless otherwise shown on Drawings.
21. Tunnel and Augered Sections: Provide constant outside diameter from bell to spigot end for pipe. Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and any stress anticipated during handling and installation.

G. Coatings and Linings:

1. Provide Portland cement; ASTM C 150, Type I or II. Provide one type of cement for entire project.
2. Water Absorption Test: ASTM C 497, Method A; perform on samples of cured mortar coating taken from each working shift. Cure mortar coating samples in same manner as pipe.
 - a. Test Value: Average minimum of 3 samples taken from same working shift, no greater than 9 percent for average value, and 11 percent for individual value.
 - b. Test Frequency: Perform tests each working shift until conformance to absorption requirements has been established by 10 consecutive passing test results, at which time testing may be performed weekly. Resume testing for each working shift if absorption test results fail until conformance to absorption requirements is reestablished by 10 consecutive passing test results.
3. Apply one coat of primer to exposed steel parts of steel bell and spigot rings. Prior to coating, blast clean in accordance with SSPC-SP7 (Brush Off Blast Cleaning). Apply primer in accordance with manufacturer's recommendations.
4. Coat and line access inlets, service outlets, test inlets and air release/vacuum relief riser pipe with same coating and lining of water line pipe in accordance with AWWA C 303, Section 4, unless otherwise indicated on Drawings.
5. Do not defer placing of coating of any portion of pipe length. Verify cement mortar coating thickness on each size of pipe by nondestructive method before removing pipe from coating machine.
6. Remove and replace disbonded lining or coating. Reject pipe requiring patches larger than 100 square inches or 12 inches in greatest dimension. Allow no more than one patch on either lining or coating of pipe. Provide WELD-CRETE Probond Epoxy Bonding Agent ET-150, parts A and B; Sikadur 32 Hi-Mod, or approved equal bonding agent for pipe patching.

H. Fittings and Specials:

1. Design fittings to same internal and external loads as straight pipe.
2. Manufacture in accordance with Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
3. Provide fabricated bends or fittings with minimum radius of 2-1/2 times pipe

diameter.

4. Design test plugs to withstand forces generated by hydrostatic test and test pressure from either side. Do not exceed 50% of minimum yield for design stresses due to hydrostatic pressure. Assume opposite side of plug does not contain water.
5. Provide no specials less than 4 feet in length unless indicated on Drawings or approved by Engineer.
6. Butt Straps for Closure Piece: Provide at locations indicated on Drawings or authorized by Engineer. Minimum 12-inch-wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Permit no angular deflection at butt-strap joints.
7. Provide minimum 6-inch welded outlet for inspecting each closure section, unless access manway is within 40 feet of closure section.
8. Provide Densco petroleum based tape or approved equal for exposed portions of nuts and bolts.

I. Joints:

1. AWWA C 303 rubber-gasketed or welded bell-and-spigot type except where flanged joints are required for valves and fittings as shown on Drawings. Refer to Section 02511 - Water Lines for details on joints and jointing.
2. Rubber-Gasketed Joints: Attach joint ring to steel cylinder with full-thickness fillet weld on the outside (single weld). Bond as shown on Drawings to provide electrical continuity along pipeline.
3. Restrained Joints: Restrain joints by welding or harnessing joints.
 - a. Design Pressure: 1.5 times working pressure.
 - b. Harnessed Joints: AWWA M 9, clamp or snap ring type, except where prohibited.
 - c. Groundwater Level: Assumed to be equal to natural ground surface.
 - d. Provide restrained joint pipe with adequate cylinder thickness to transmit full thrust generated by internal pressure across joints.
 - 1) Calculate distance of restrained joints based on resistance along each leg of bend with thrust based on bend angle.

- 2) Cylinder thickness not to be less than that defined in AWWA C303, Table 2, and minimum nominal cylinder thickness.
 - 3) Allow cylinder thickness to reduce linearly from maximum calculated thickness to minimum thickness required by design over required length (as determined in Paragraph 2.01 J.3.d.1) of restrained joints.
 - 4) Provide full circumferential welds at joints required to be welded. Double weld joint rings in areas of thrust.
- J. Use only fully circumferentially welded joints in areas considered potentially petroleum contaminated, within tunnels and under foreign pipelines. Perform welding in accordance with Section 02502 - Steel Pipe and Fittings and Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
- K. Pipe Flanges: AWWA C 207 for standard steel flanges of pressure class corresponding to pipe class.
- L. Pipe lengths: Provide pipe sections in standard lengths with minimum length of 16 feet and maximum length of 25 feet, and as indicated on approved shop Drawings or approved by Engineer. Gasketed joints are allowed on standard lengths of pipe. Non-standard pipe lengths must be approved by Engineer and joints must be welded as specified herein to achieve equal to or greater than standard pipe length before gasketed joints can be used. Internally and externally mark pipe section with durable marking to show location and pipe pressure.
- M. Hydrostatic Test of Cylinder: In accordance with AWWA C 303, at point of manufacture. Hold test for minimum 2 minutes for thorough inspection of cylinder. Repair or reject cylinders revealing leaks or cracks.
- N. Transport fittings with end caps. Remove end caps just prior to installation.
- O. Transport fittings 36 inches in diameter and larger with stulls. Remove stulls after completion of backfill.
- P. Provide radius of curve as indicated on Drawings unless approved by Engineer. Make curves and bends by deflecting joints, by use of beveled joints, or by combination of two methods, unless otherwise indicated on Drawings. Do not exceed deflection angle recommended by pipe manufacturer. Provide beveled pipe sections of standard length used in curved alignment, except when shorter sections are required to limit radius of curvature. In such case, provide sections throughout curve of substantially equal length.
- Q. When manufacturing straight pipe sections, manual welding is allowed for following:
 1. Tack welding of coils and plates during continuous pipe making process.

2. Rewelding and repairing structural defects in plate and automatic machine welds.
3. Attaching new coil of steel to previous coil.

2.2 BAR ROD

- A. Conform to requirements of ASTM A 615, AWWA C 303 and this specification.
- B. Test foreign manufactured rod by local independent laboratory.
- C. Rod manufacturer is responsible for performing mechanical tests required in ASTM A 615.
- D. Pipe manufacturer is responsible for requiring rod manufacturer to submit certified results of chemical and mechanical tests, performed by rod manufacturer. Pipe manufacturer is responsible for performing mechanical tests, and is required to attest to such in affidavit of compliance.
- E. Do not use rod with visible pitting.

2.3 GROUT FOR JOINTS AND SPECIAL APPLICATION

- A. Joint Grout:
 1. Cement Grout Mixture: One part cement to two parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream.
 2. Water: Potable water with total dissolved solids less than 1000 mg/l; ASTM D 512 chloride ions less than 100 mg/l for slurry and mortar cure; ASTM D 1293 pH greater than 6.5. Use potable water with 250ppm limit on chlorides and sulfates.
 3. Portland Cement: ASTM C 150, Type I or II. Provide one type of cement for entire project.
 4. Sand:
 - a. Interior joints: ASTM C 35 fine graded plaster sand.
 - b. Exterior joints: ASTM C 33 natural sand with 100 percent passing No. 16 sieve.
 5. Mix cement grout to specific gravity of 19 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and as requested by Engineer. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout mixed more than

20 minutes that is not at proper moisture content or specific gravity.

- B. Nonshrink Grout for Special Applications, Patches and Repairs.
1. Conform to requirements of ASTM C 1107, Nonshrink Grout.
 2. Pre-blended factory-packaged material manufactured under rigid quality control.
 3. Contain non-metallic natural aggregate, be nonstaining and noncorrosive.
 4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.
 5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.
 6. Non-bleeding and non-segregating at fluid consistency.
 7. Contain no chlorides or additives which may contribute to corrosion of bar wrapped steel cylinder pipe.
 8. Free of gas-producing, gas-releasing agents.
 9. Resist attack by oil or water.
 10. Mix, place, and cure in accordance with manufacturer's recommendations. Upon 72 hours' notice, provide services of qualified representative of nonshrink grout manufacturer to aid in use of product under job conditions.
 11. Mix nonshrink grout to specific gravity of 17.7 lb/gallon or greater as measured by grout/slurry balance. Use grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and as requested by Engineer. Add additional non-shrink grout to mixed non-shrink grout to bring to proper moisture content or specific gravity. Discard grout mixed more than 20 minutes that is not at proper moisture content or specific gravity.
 12. Compressive strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.
- C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.
- D. Joint Wrapper: Minimum width of 9 inches for 33-inch diameter and smaller; minimum width of 12 inches for diameters greater than 33-inch hemmed at edge to allow threading with minimum 5/8-inch wide steel strap. Provide minimum 6-inch wide Ethafoam strip

sized, positioned, and sewn such that two circumferential edges of Ethafoam are 1-1/2-inches from outer edge of wrapper.

2.4 CATHODIC PROTECTION

- A. Connect each joint of pipe with bonding straps or approved devices to maintain continuity of current. Provide bonding straps free of foreign material.
- B. Electrically isolate water line from other connections. Use insulating type joints or non-metallic pipe unless otherwise indicated on Drawings.
- C. Provide flange adapter with insulating kit as required when connecting new piping to existing piping.

2.5 INSPECTION AND SHIPPING

- A. Permit Engineer to inspect pipes or witness pipe manufacturing. Inspection shall not relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications. Should Engineer elect not to inspect manufacturing, testing, or finished pipes, it in no way implies approval of products or tests.
- B. Manufacturer's Notification to Customer: Should Engineer wish to see specific pipes during manufacturing process, manufacturer shall provide Engineer with minimum of three (3) weeks advance notice of when and where production of those pipes will take place. Repair damage to pipe or protective lining per manufacture specifications before final acceptance.
- C. Shipping: Where required, provide pipe and fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Conform to requirements of Section 02511 - Water Lines. Do not install pipe without approved lay schedule.
- B. Install pipe within six months of pipe being manufactured.
- C. Manufacturer shall make available services of representative, throughout project duration when deemed necessary by Engineer, to advise aspects of installation including but not limited to handling, storing, cleaning and inspecting, coatings and linings repairs, and general construction methods affecting pipe.
- D. Bedding and Backfilling

1. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
 2. Take necessary precautions during bedding and backfilling operations to prevent deformation or deflection of cylindrical shape of pipe by more than allowable pipe deflection.
 3. Do not move trench support system (trench safety system) once bedding material is compacted.
 4. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.
 5. Excavate outside specified trench section for bell holes, and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes as required or directed by Engineer. Subsequent backfilling thereof shall not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of Engineer.
 6. Remove blocking after placing sufficient backfill to hold pipe in position.
- E. Follow nonshrink grout manufacturer's specifications for nonshrink grouting.
- F. Store pipe at job-site with securely-fastened plastic end caps to maintain moist pipe interior. Promptly replace damaged end caps to avoid shrinkage or cracking of cement-mortar lining. Immediately replace damaged plastic end caps. Do not leave uncapped for more than 4 hours.
- G. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by Engineer, in-place survey data for pipe laid each day and submit copy of data to Engineer at end of that day. Survey data to include unique pipe number, deflection angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom, and at springline (each side).
- H. Static Electricity:
1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.
 2. Electrically test where required after installation of pipeline is complete.

3.2 DEFLECTION

- A. Allowable deflection from specified diameter determined as follows:
Allowable Deflection = $(D)^2/4000$, (D= Nominal inside pipe diameter in inches).
- B. Deflection may be measured by Engineer at location along pipe. Arithmetical averages of deflection are not acceptable.
- C. If deflection exceeds that specified, remove entire portion of deflected pipe section and install new pipe as directed by Engineer at no cost to Authority.

3.3 CLOSURES AND APPROVED PIPE MODIFICATIONS.

- A. No modifications of standard pipe for closures shall be permitted in field. No field cutting of pipe or exposure of bar wire is permitted without written approval from Engineer.
- B. Pipe manufacturer's representative and Engineer to entirely witness closures and approved pipe modification efforts.
- C. Provide minimum lap of 4 inches between member being joined and edge of butt strap. Weld on both interior and exterior, unless otherwise approved by Engineer.
- D. Provide full circumferential welds on joints required to be welded. Employ independent certified testing laboratory, approved by Engineer, to perform weld tests on field welds. Include cost of such testing in contract unit price for water line. Use magnetic particle test method for lap welds or X-ray methods for butt welds, for 100 percent of joint welds. Maintain records of tests. If defective weld is revealed, repair defective weld, and retest. Use wire and flux from same manufacturer throughout entire project.
- E. Fill wrapper in field and allowing excess grout water to seep out. Refill wrapper as necessary. When joint mortar level has stabilized and begun to mechanically stiffen, lap Ethafoam wrapper over top of joint, and secure in place.
- F. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

3.4 VISIBLE CRACKS

- A. No visible cracks longer than 6 inches, measured to be within 15 degrees of line parallel to pipe longitudinal axis, are permitted except:
 - 1. In surface laitance of centrifugally cast concrete,
 - 2. In sections of pipe with steel reinforcing collars or wrappers, or
 - 3. Within 12 inches of pipe ends.
- B. Repair interior lining cracks that exceed 1/16-inch (0.0625 inches) wide.

- C. Reject pipe with exterior coating cracks that exceed 0.01 inches wide.
- D. Immediately remove pipe from site if pipe has cracks exceeding limitations and cracks are not repairable.

3.5 FIELD REPAIR PROCEDURES FOR COATING/LINING

- A. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with nonshrink grout conforming to section 2.03 B. Use only manual or small (low pressure) air chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with nonshrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off nonshrink grout flush with surrounding surface after patch has stiffened sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.
- B. Pipe with defective coating areas greater than 6 inches in diameter cannot be used. Immediately remove pipe from project.
- C. Reject pipe if steel cylinder is dented while making field repair. Immediately remove pipe from project.

END OF SECTION

Section 02621

GEOTEXTILE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Geotextile, also called filter fabric, in applications including pipe embedment wrap, around exterior of tunnel liner, around foundations of pipeline structures, and slope stabilization.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for Work performed under this Section. Include cost of Work in unit prices for Work requiring geotextile.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. AASHTO M 288 - Standard Specification for Geotextile Specification for Highway Applications.
- B. ASTM D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- C. ASTM D 4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- D. ASTM D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles (Grab Method).
- E. ASTM D 4751 - Standard Test Method for Determining Apparent Opening Size of Geotextiles.
- F. ASTM D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit standard manufacturer's catalog sheets and other pertinent information, for approval, prior to installation.
- C. Submit installation methods, as part of Work plan for tunneling or for excavation and backfill for utilities. Obtain approval from the Engineer for filter fabric material and proposed installation method prior to use of filter fabric.

PART 2 P R O D U C T S

2.01 GEOTEXTILE

- A. Provide geotextile (filter fabric) designed for use in geotechnical applications. Filter fabric shall provide permeable layer or media while retaining soil matrix.
- B. Use fabric which meets physical requirements for Class A subsurface drainage installation conditions as defined in AASHTO M 288 and as specified in Paragraph 2.02, Properties.

2.02 PROPERTIES

- A. Material: Nonwoven, non-biodegradable, fabric consisting of continuous chain polymer filaments or yarns, at least 85 percent by weight polyolefins, polyesters or polyamide, formed into dimensionally stable network.
- B. Chemical Resistance: Inert to commonly encountered chemicals and hydrocarbons over pH range of 3 to 12.
- C. Physical Resistance: Resistant to mildew and rot, ultraviolet light exposure, insects and rodents.
- D. Minimum Test Values:

Property	Value (Min.)	Test Method
Grab Strength	180 lbs.	ASTM D 4632
Trapezoidal Tear Strength	50 lbs.	ASTM D 4533
Puncture Strength	80 lbs.	ASTM D 4833
Mullen Burst Strength	290 psi.	ASTM D 3786

Apparent Opening Size ⁽¹⁾	0.25 mm	ASTM D 4751
Permittivity (sec ⁻¹)	0.2	ASTM D 4491
⁽¹⁾ Maximum average roll value.		

PART 3 E X E C U T I O N

3.01 LINE WORK

- A. Conform use of geotextile to backfill for utilities to Section 02317 - Excavation and Backfill for Utilities.

3.02 TUNNEL WORK

- A. Use geotextile outside of tunnel primary liner to prevent migration of soil fines into excavated tunnel resulting in voids or settlement. Select geotextile, subject to minimum requirements of Paragraph 2.02, meeting tunnel liner design requirements and installation conditions.
1. Sewers: Conform to Section 02426 - Sanitary Sewer Line in Tunnel.
 2. Waterlines: Conform to Section 02517 - Waterline in Tunnels.

END OF SECTION

Section 02631

STORM SEWERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. New storm sewers and appurtenances, modifications to existing storm sewer system and installation of roadside ditch culverts.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for storm sewers, including elliptical or box storm sewer, installed by open-cut, augered with or without casing, or tunneling is on linear foot basis. Measurement for storm sewers and roadside ditch culverts will be taken along center line of pipe from center line to center line of manholes or from end to end of culverts. Measurement for storm sewer will be taken along center line of storm sewer from inside wall of storm sewer junction box when installed in conjunction with storm sewer junction box. Payment will be made for each linear foot installed complete in place, including connections to existing manholes and inlets.
 - 2. Payment for storm sewer leads, including elliptical leads, is on a linear foot basis.
 - 3. Payment for corrugated metal pipe storm sewer outfall, including timber bents, is on a linear foot basis.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 DEFINITIONS

- A. Long Run Culvert: A culvert which is 40 feet or more in length.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's literature for product specifications and installation instructions.

- C. Submit proposed methods, equipment, materials, and sequence of operations for sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.
- D. For flexible pipe products, submit detailed calculations per AASHTO LRFD Bridge Design Specifications. Designs are required for each pipe location and are to be signed and sealed by a licensed engineer.

1.5 QUALITY ASSURANCE

- A. The Condition for acceptance shall be watertight storm sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections.
- B. Provide manufacturer's certification to Specifications.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's recommendations.
- B. Handle pipe, fittings, and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks or trailers. Do not use Materials cracked, gouged, chipped, dented, or otherwise damaged shall not be use materials for installation.
- C. Store pipe and fittings on heavy timbers or platforms to avoid contact with ground.
- D. Unload pipe, fittings, and appurtenances as close as practical to location of installation to avoid unnecessary handling.
- E. Keep interiors of pipe and fittings free of dirt and foreign matter.
- F. Store thermoplastic (PVC, HDPE, PP) pipe out of direct sunlight.

PART 2 PRODUCTS

2.1 PIPE

- A. Provide piping materials for storm sewers shall be of sizes and types specified unless otherwise indicated on Drawings.
- B. In diameters where material alternatives are available, provide pipe from single manufacturer for each pipe diameter, unless otherwise approved by Engineer or otherwise shown on Drawings.
- C. Existing pipe that has been removed during construction cannot be reused.

2.2 PIPE MATERIAL SCHEDULE

- A. Storm Sewer Pipe: Use pipe materials that conform to requirements specified in one or more of the following Sections as shown on the Drawings.
 - 1. Section 02506 - Polyvinyl Chloride Pipe. Not allowed in the following applications:
 - a. Potentially Petroleum Contaminated Areas (PPCA).
 - b. Augering/ jacking
 - 2. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe and Section 02510 – Polypropylene (PP) Corrugated Wall Pipe. For use only where Storm Sewers are associated with Local Streets.
 - 3. Section 02611 - Reinforced Concrete Pipe.
 - 4. Section 02612 - Precast Reinforced Concrete Box Sewers.
 - 5. Section 02642 - Corrugated Metal Pipe use only where Corrugated Metal Pipe is shown on Drawings.
- B. Driveway Culvert Pipe for Streets with Open Ditches: Use pipe materials conforming to requirements specified in one or more of the following Sections as shown on the Drawings.
 - 1. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe and Section 02510 – Polypropylene (PP) Corrugated Wall Pipe. Use for Residential Culverts only. Use Concrete Pipe for long run culverts.
 - 2. Section 02611 - Reinforced Concrete Pipe.
 - 3. Section 02612 - Precast Reinforced Concrete Box Sewers.
- C. Provide pipe meeting minimum class, dimension ratio, or other criteria indicated.
- D. Pipe materials other than those listed above shall not be used for storm sewers.

2.3 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

- A. Bedding and Backfill Material: Conform to requirements of Sections 02317 - Excavation and Backfill for Utilities, Section 02320 - Utility Backfill Material, and Section 2321 – Cement Stabilized Sand, and Section 02322 – Flowable Fill.
- B. Topsoil: Conform to requirements of Section 02911 - Topsoil.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation when construction will affect traffic. Conform to requirements of Section 01555 Traffic Control and Regulation.
- B. Provide barricades, flashing warning lights, and signs for excavations. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections while Work is in progress or where traffic is affected by Work.
- C. Immediately notify agency or company owning utility lines which are damaged, broken, or disturbed. Obtain approval from Engineer and agency for repairs or relocations, either temporary or permanent.
- D. Remove old pavements and structures, including sidewalks and driveways in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- E. Install and operate dewatering and surface water control measures in accordance with Section 01578 - Control of Ground and Surface Water.

3.2 EXCAVATION

- A. Earthwork. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities. Use bedding as indicated on Drawings.
- B. Line and Grade. Establish required uniform line and grade trench from benchmarks identified by Engineer. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of Work. Or use appropriately sized grade boards which are substantially supported.
- C. Trench Excavation. Excavate pipe trenches to level as indicated on Standard Details. Backfill excavation with specified bedding material to level of lower one-third of pipe barrel. Tamp and compact backfill to provide bedding at indicated grade. Form bedding foundation to minimum depth of one-eighth of pipe diameter, but not less than 12-inches.

3.3 PIPE INSTALLATION

- A. Install in accordance with pipe manufacturer's recommendations and as specified in this section.
- B. Install pipe only after excavation is completed, bottom of trench is shaped, bedding material is installed, and trench has been approved by Engineer.

- C. Install pipe to line and grade indicated on Drawings. Place pipe so that it has continuous bearing of barrel on bedding material with no voids, and is laid in trench so interior surfaces of pipe follows grades and alignments indicated.
- D. Install pipe with bells of pipe facing upstream of anticipated flow.
- E. Form concentric joint with each section of adjoining pipe to prevent offsets.
- F. Place and drive home newly laid sections with a sling or come-a-long winches to eliminate damage to sections. Unless otherwise approved by Engineer, provide end protection to prevent damage while using back hoes or similar powered equipment to drive home newly laid sections.
- G. Keep interior of pipe clean as installation progresses.
- H. Keep excavations free of water during construction and until final inspection.
- I. When work is not in progress, cover exposed ends of pipes with pipe plug specifically designed to prevent foreign material from entering pipe.
- J. For Flexible Pipe Products:
 - 1. Provide a minimum cover as per Authority Standard detail from top of pavement to top of pipe, but no less than 2 feet.
 - 2. Accomplish transitions to different material of pipe in a manhole or inlet box. No adapter, coupling for dissimilar pipe, or saddle connections allowed.
 - 3. Provide pipe sections in standard lengths with minimum length of 13 feet. Pipe may be field modified to shorten length no less than 4 feet, unless otherwise approved by Engineer. Field modify pipe per manufacturer's recommendations.
 - 4. No beveling at joint allowed. Cut to be perpendicular to longitudinal axis.
 - 5. Provide gasketed bell and spigot joints installed per manufacturer's recommendations. Gasketed pipe joints; clean and free of debris, show no leakage after installation.

3.4 PIPE INSTALLATION OTHER THAN OPENCUT OR TUNNELING

- A. Conform to requirements of Section 02448 - Pipe and Casing Augering for Sewers where required.
- B. Conform to requirements of Section 02441 - Microtunneling and Pipe-Jacked Tunnels where required.

- C. Not allowed for plastic sewer pipe.

3.5 INSTALLATION OF APPURTENANCES

- A. Construct manholes to conform to requirements of Sections 02081 - Cast-in-place Concrete Manholes, and Section 02082 - Precast Concrete Manholes. Install frames, grate rings, and covers to conform to requirements of Section 02090 - Frames, Grates, Rings, and Covers.
- B. Install PVC pipe culverts with approved end treatments. Approved end treatments include concrete headwalls, wingwalls and collars. Refer to details for end treatment requirements.
- C. Install HDPE and PP pipe culverts with approved end treatments. Approved end treatments include concrete headwalls, wingwalls and collars. Refer to details for end treatment requirements.
- D. Install inlets, headwalls, and wingwalls to conform to requirements of Section 02632 - Cast-in-place Inlets, Headwalls, and Wingwalls and Section 02633 - Precast Concrete Inlets, Headwalls, and Wingwalls.
- E. Rehabilitate existing manholes to conform to requirements of Section 02555 – Manhole Rehabilitation. Adjust manhole covers and inlets to grade conforming to requirements of Section 02086 - Adjusting Manholes, Inlets, and Valve Boxes to Grade.
- F. Dimension for Type C and Type E manholes shall be as shown on Drawings.

3.6 INSPECTION AND TESTING

- A. Perform post installation television inspection in accordance with Section 02531 – Gravity Sanitary Sewers. Hand held cameras may be used in storm sewers in lieu of requirements of Paragraph 3.09 of Section 02531 – Gravity Sanitary Sewers. Clearly stencil distance markings on each joint of pipe to indicate distance from starting manhole when using hand held cameras.
- B. MANDREL TESTING: use a mandrel to test flexible pipe for deflection. Refer to Section 02533 – Acceptance Testing for Sanitary Sewers for the mandrel and test requirements.

3.7 BACKFILL AND SITE CLEANUP

- A. Backfill trench after pipe installation is inspected and approved by Engineer.
- B. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.
- C. Repair and replace removed or damaged pavement and sidewalks as specified in Section 02951 - Pavement Repair and Restoration.

- D. In unpaved areas, grade surface as uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil and seed according to requirements of Section 02921 Hydromulch Seeding, or Section 02922 - Sodding, as required.

END OF SECTION

Section 02632

CAST-IN-PLACE INLETS, HEADWALLS AND WINGWALLS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Cast-in-place inlets for storm or sanitary sewers, including cast iron frame and plate or grate.
- B. Cast-in-place headwalls including wingwalls for storm sewers.
- C. Cast-in-place junction box with lid or grate top.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for cast-in-place inlets is on unit price basis for each inlet installed.
 - 2. Payment for cast-in-place headwalls including wingwalls is on unit price basis for each headwall including wingwall installed.
 - 3. Payment for cast-in-place junction box with lid or grate top is on unit price basis for each junction box installed.
 - 4. Payment for inlets and for culvert headwalls including wingwalls and junction boxes includes connection of lines and furnishing and installing frames, grates, rings, and covers.
 - 5. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this section is included in total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings for approval of design and construction details for cast-in-place units which differ from units shown on Drawings.

- C. Submit manufacturers' data and details for frames, grates, rings, and covers.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Concrete: Class A concrete with minimum compressive strength of 4000 psi conforming to requirements of Section 03315 - Concrete for Utility Construction, unless otherwise indicated on Drawings.
- B. Reinforcing Steel: Conform to requirements of Section 03315 - Concrete for Utility Construction.
- C. Mortar and Hydraulic Cement - Conform to requirements of Section 04061 - Mortar.
- D. Miscellaneous metals: Cast-iron frames, grates, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify lines and grades are correct.
- B. Verify compacted subgrade will support loads imposed by inlets.

3.2 INSTALLATION

- A. Construct units complete in place to dimensions, lines and grades as shown on Drawings.
- B. Excavate in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities.
- C. Construct box section of inlet of Class A concrete
- D. Forms required for both outside and inside faces of concrete inlet walls, however, when nature of material excavated for inlet can be hand trimmed to smooth vertical face, outside forms may be omitted with approval of Engineer.
- E. Place reinforcing steel to conform to details shown on Drawings. Provide positive means for holding steel cages in place during concrete placement. Welding of reinforcing steel is not permitted unless noted on Drawings.

Maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2 inch, whichever is less. Regardless of variation, maintain minimum cover of concrete over reinforcement as shown on Drawings.

- F. Chamfer exposed edges unless otherwise indicated on Drawings.

3.3 FINISHES

- A. Cut off inlet leads neatly at inside face of inlet wall. Point up with mortar.
- B. When box section of inlet complete, shape floor of inlet with mortar to conform to detailed Drawings.
- C. Finish concrete surfaces in accordance with requirements of Section 03315 - Concrete for Utility Construction.

3.4 QUALITY CONTROL

- A. Verify that inlets are free of leaks. Repair leaks in approved manner.

3.5 CONNECTIONS

- A. Connect inlet leads to inlets.
- B. Seal leads inside and outside with hydraulic cement.

3.6 BACKFILL

- A. Backfill area of excavation surrounding each completed inlet according to requirements of Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

Section 02633

PRECAST CONCRETE INLETS, HEADWALLS, AND WINGWALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Precast concrete inlets for storm or sanitary sewers, including cast iron frame and plate or grate.
- B. Precast concrete headwalls and wingwalls for storm sewers.
- C. Precast junction box with lid or grate top.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for inlets is on unit price basis for each inlet installed.
 - 2. Payment for headwalls and wingwalls is on unit price basis for each headwall and wingwall installed.
 - 3. Payment for junction box with lid or grate top is on unit price basis for each junction box installed.
 - 4. Payment for inlets, headwalls, wingwalls, and junction boxes includes connection of lines and furnishing and installing frames, grates, rings, and covers.
 - 5. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
- B. ASTM C 858 - Standard Specification for Underground Precast Concrete Utility Structures

- C. ASTM C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings for approval of design and construction details for precast concrete inlets, junction box headwalls, and wingwalls. Precast units differing from standard designs shown on Drawings will be rejected unless shop drawing submittals are approved. Clearly show proposed substitution is equal or superior in every aspect to standard designs.
- C. Submit manufacturers' data and details for frames, grates, rings, and covers.

1.5 STORAGE AND SHIPMENT

- A. Store precast units on level blocking. Do not place loads until design strength is reached. Shipment of acceptable units may be made when 28-day strength requirements have been met.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Concrete: Provide concrete for precast machine-made units meeting requirements of ASTM C 858 regarding reinforced concrete, cement, aggregate, mixture, and concrete test. Minimum 28-day compressive strength shall be 4,000 psi.
- B. Reinforcing Steel: Place reinforcing steel to conform to details shown on Drawings and as follows:
 - 1. Provide positive means for holding steel cages in place throughout production of concrete units. Maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2-inch, whichever is less. Regardless of variation, maintain minimum cover of concrete over reinforcement as shown on Drawings.
 - 2. Welding of reinforcing steel is not permitted unless noted on Drawings.
- C. Mortar and Hydraulic Cement: Conform to requirements of Section 04061-Mortar.

- D. Miscellaneous Metal: Cast-iron frames and plates conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

2.2 SOURCE QUALITY CONTROL

- A. Tolerances: Allowable casting tolerances for concrete units are plus or minus 1/4-inch from dimensions shown on Drawings. Concrete thickness in excess of that required will not constitute cause for rejection provided that excess thickness does not interfere with proper jointing operations.
- B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on inside of inlet, headwall, or wingwall.
- C. Rejection: Precast units rejected for non-conformity with these specifications and for following reasons:
 - 1. Fractures or cracks passing through shell, except for single end crack that does not exceed depth of joint.
 - 2. Surface defects indicating honeycombed or open texture.
 - 3. Damaged or misshaped ends, where damage would prevent making satisfactory joint.
- D. Replacement: Immediately remove rejected units from Work site and replace with acceptable units.
- E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in opinion of Engineer, repaired units conform to requirements of these specifications.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify lines and grades are correct.
- B. Verify compacted subgrade will support loads imposed by inlets.

3.2 INSTALLATION

- A. Install units complete in place to dimensions, lines, and grades as shown on Drawings.
- B. Excavate in accordance with requirements of Section 02317 - Excavation and

Backfill for Utilities.

- C. Bed precast concrete units on foundations of firm, stable material shaped to conform to shape of unit bases.
- D. Provide adequate means to lift and place concrete units.

3.3 FINISHES

- A. Use hydraulic cement to seal joints, fill lifting holes and as otherwise required.
- B. When box section of inlet has been completed, shape floor of inlet with mortar to conform to Drawing details.
- C. Adjust cast iron inlet plate frames to line, grade, and slope shown on Drawings. Grout frame in place with mortar.

3.4 QUALITY CONTROL

- A. Verify that inlets are free of leaks. Repair leaks in approved manner.

3.5 CONNECTIONS

- A. Connect storm sewer leads to inlets as shown on Drawings. Seal connections inside and outside with hydraulic cement. Make connections watertight.

3.6 BACKFILL

- A. Backfill area of excavation surrounding each completed inlet, headwall, or wingwall according to requirements of Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

Section 02642

CORRUGATED METAL PIPE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Corrugated metal pipe (CMP).
- B. Corrugated metal pipe with smooth interior (CMPSI).

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for corrugated metal pipe in open cut under this Section. Include payment in unit price for Section 02631 - Storm Sewers.
 - 2. No payment will be made for corrugated metal pipe in non-open cut under this Section. Include payment in unit price for applicable tunneling section.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AASHTO M 36 - Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
- B. AASHTO M 190 - Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
- C. AASHTO M 196 - Corrugated Aluminum Pipe for Sewers and Drains.
- D. AASHTO M 197 - Aluminum Alloy Sheet for Corrugated Aluminum Pipe.
- E. AASHTO M 218 - Steel Sheet, Zinc Coated (Galvanized) for Corrugated Steel Pipe.
- F. AASHTO M 232 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

- G. AASHTO M 245 - Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains.
- H. AASHTO M 246 - Steel Sheet, Metallic-Coated and Polymer Precoated for Corrugated Steel Pipe.
- I. AASHTO M 274 - Steel Sheet, Aluminum-Coated (Type 2) for Corrugated Steel Pipe.
- J. ASTM B 633 - Standard Specification for Electro deposited Coatings of Zinc on Iron and Steel.
- K. ASTM A 760 - Standard Specifications for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
- L. ASTM A 798 – Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings and calculations with the following information:
 - 1. Design dimensions and details for pipe and fittings indicating alignment, grade, and laying dimensions.
 - 2. Fabrication details, details of fittings and flanges, details of specials, and proposed welding procedures.
 - 3. Show station numbers for pipe and fittings corresponding to Drawings.
 - 4. Submit detailed calculations per AASHTO LRFD Bridge Design Specifications. Designs are required for each pipe location and are to be signed and sealed by a licensed engineer.

1.5 QUALITY ASSURANCE

- A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section, and that coatings and linings were not applied or allowed to cure in freezing temperatures.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

- A. Corrugated metal pipe may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel as indicated on Drawings and conforming to following:

Galvanized Steel	AASHTO M 218
Aluminized Steel	AASHTO M 274
Aluminum	AASHTO M 197
Precoated Galvanized Steel	AASHTO M 246

1. Reference to gauge of metal is to U.S. Standard Gauge for uncoated sheets. Tables in AASHTO M 218 and AASHTO M 274 list thicknesses for coated sheets in inches. Tables in AASHTO M 197 list thicknesses in inches for clad aluminum sheets.
- B. Coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to requirements of AASHTO M 36 for steel pipe and AASHTO M 196 for aluminum pipe.
1. Coupling bands shall be not more than 3 nominal sheet thicknesses lighter than thickness of pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.
 2. Coupling bands shall be made of same base metal and coating (metallic or otherwise) as pipe.
 3. Minimum width of corrugated locking bands shall be as shown below for corrugations which correspond to end circumferential corrugations on pipes being joined:
 - a. 10-1/2-inches wide for 2-2/3-inch by 1/2-inch corrugations.
 - b. 12-inches wide for 3-inch by 1-inch corrugations.
 4. Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join new pipe to existing pipe which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at ends shall be field jointed with either helically corrugated bands or with bands with projections (dimples). Minimum width of helical corrugated bands shall conform to following:
 - a. 12-inches wide for 1/2-inch deep helical end corrugations.
 - b. 14-inches wide for 1-inch deep helical end corrugations.

5. Bands with projections shall have circumferential rows of projections with one projection for each corrugation. Width of bands with projections shall be not less than following:
 - a. 12-inches wide for pipe diameters up to and including 72-inches. Bands shall have two circumferential rows of projections.
 - b. 16-1/4-inches wide for pipe diameters of 78-inches and greater. Bands shall have four circumferential rows of projections.
 6. Bolts for coupling bands shall be 1/2-inch diameter. Bands 12-inches wide or less will have minimum of 2 bolts per end at each connection, and bands greater than 12-inches wide shall have minimum of 3 bolts at each connection.
 7. Galvanized bolts may be hot dip galvanized in accordance with requirements of AASHTO M 232, mechanically galvanized to provide same requirements as AASHTO M 232, or electro galvanized per ASTM B 633, Type RS.
- C. Coat bituminous coated pipe or pipe arch inside and out with bituminous coating which shall meet these performance requirements and requirements of AASHTO M 190.
1. Uniformly coat pipe inside and out to minimum thickness of 0.05-inch, measured on crests of corrugations.
 2. Adhere bituminous coating to metal so that it will not chip, crack, or peel during handling and placement; and to protect pipe from corrosion and deterioration.
 3. Where paved invert is shown on Drawings, pipe or pipe arch, in addition to fully-coated treatment described above, shall receive additional bituminous material, same as specified above, applied to bottom quarter of circumference to form smooth pavement. Maintain minimum thickness of 1/8-inch above crests of corrugations.
- D. Furnish fittings and specials required for bends, end sections, branches, access manholes, and connections to other fittings. Design fittings and specials in accordance with Drawings and ASTM A 760. Fittings and specials are subject to same internal and external loads as straight pipe.
- 2.2 PIPE FABRICATION
- A. Steel Pipe:

1. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO M 36, Type I, Type IA, or Type II, as indicated on Drawings.
 2. Fabrication with circumferential corrugations, lap joint construction with riveted or spot- welded seams, helical corrugations with continuous helical lock seam, or ultra-high frequency resistance butt-welded seams is acceptable.
- B. Aluminum Pipe:
1. Conform to requirements of AASHTO M 196, Type I, Type IA, circular pipe, or Type II, pipe arch as indicated on Drawings.
 2. Fabrication with circumferential corrugations, lap joint construction with riveted or spot- welded seams, or helical corrugations with continuous helical lock seam.
 3. Portions of aluminum pipe that will be in contact with concrete or metal other than aluminum shall be insulated from these materials with coating of bituminous material meeting requirements of AASHTO M 190. Extend coating minimum distance of one foot beyond area of contact.
- C. Precoated Galvanized Steel Pipe:
1. Pipe shall be full circle or arch pipe conforming to AASHTO M 245, Type I, Type IA or Type II as indicated on Drawings.
 2. Fabrication with circumferential corrugations, lap joint construction with riveted seams, or helical lock seams is acceptable.
 3. Inside and outside coating shall be minimum of 10 mils.

PART 3 EXECUTION

3.1 PREPARATION

- A. Repair damaged spelter coating by thoroughly wire brushing damaged area and removing all loose, cracked, or weld-burned spelter coating. Paint cleaned area with zinc dust-zinc oxide paint conforming to Federal Specifications TT-P-641g.
- B. Repair damaged aluminized or polymer coating in accordance with manufacturer's recommendations.

3.2 EARTHWORK

- A. Excavate in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities, except where tunneling or jacking methods are shown on Drawings. When pipes are laid in trench, trench when completed and shaped to receive pipe, shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of backfill and bedding material under and around pipe.
- B. Bed pipe in accordance with Drawings. When requested by Engineer, furnish simple template for each size and shape of pipe for use in checking shaping of bedding. Template shall consist of thin plate or board cut to match lower half of cross section.
- C. Where rock in either ledge or boulder form exists below pipe, remove rock below grade and replace with suitable materials so slightly yielding compacted earth cushion is provided below pipe minimum of 12-inches thick.
- D. Remove and replace where soil encountered at established grade is quicksand, muck or similar unstable materials in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities. Do not allow cement stabilized materials for backfill to come into contact with uncoated aluminum or aluminized pipe surface.
- E. After metal pipe structure has been completely assembled on proper line and grade and headwalls constructed when required by drawing details, place selected material from excavation or borrow along both sides of completed structures equally, in uniform layers not exceeding 6 inches in depth (loose measurement), wetted when required and thoroughly compacted between adjacent structures and between structure and sides of trench, or for distance each side of structure equal to diameter of pipe. Compact backfill material to same density requirements as specified for adjoining sections of embankment in accordance with specifications. Above three-fourths point of structure, place uniformly on each side of pipe in layers not to exceed 12-inches.
- F. Only hand operated tamping equipment will be allowed within vertical planes 2-feet beyond horizontal projection of outside surface of structure for backfilling, until minimum cover of 12-inches is obtained. Remove and replace damaged pipe.
- G. Do not permit heavy earth moving equipment to haul over structure until minimum of 4-feet of permanent or temporary compacted fill has been placed.
- H. During backfilling, obtain uniform backfill material and uniform compacted density throughout length of structure to avoid unequal pressure. Provide proper foundation and bedding under the structure in accordance with ASTM A 798.
- I. Prior to adding each new layer of loose backfill material, inspection will be made

of inside periphery of structure for local or unequal deformation caused by improper construction methods. Evidence of deformation will be reason for corrective measures as may be directed by Engineer.

3.3 PIPING INSTALLATION

- A. Place pipes on prepared foundation starting at outlet end. Join sections firmly together, with side laps or circumferential joints pointing upstream and with longitudinal laps on sides.
- B. Coat metal in joints not protected by galvanizing or aluminizing with approved asphaltum paint.
- C. Provide proper equipment for hoisting and lowering sections of pipe into trench without damaging pipe or disturbing prepared foundation and sides of trench. Take up and re-lay pipe which is not in alignment or which shows undue settlement after laying, or is damaged.
- D. Lay multiple installations of corrugated metal pipe and pipe arches with center lines of individual barrels parallel. Unless otherwise indicated on Drawings, maintain following clear distances between outer surfaces of adjacent pipes:

<u>Diameter of Pipe</u>	<u>Clear Distance Between Pipes Full Circle and Pipe Arch</u>	<u>Pipe Arch Design No.</u>
18"	1'-2"	2
24"	1'-5"	3
30"	1'-8"	4
36"	1'-11"	5
42"	2'-2"	6
48"	2'-5"	7
54"	2'-10"	8
60"-84"	3'-2"	9
90"-120"	3'-5"	10 & Over

- E. Where extensions are attached to existing structures, install proper connection between structure and existing as indicated on Drawings, coat connection with bituminous material when required.
- F. When existing headwalls and aprons are indicated for reuse on Drawings, sever portion to be reused from existing culvert, and relocate to prepared position. Restore damaged headwalls, aprons or pipes attached to headwall to their original condition.

3.4 JOINTING

- A. Use field joints to maintain pipe alignment during construction and prevent infiltration of side material.
- B. Lap coupling bands equally on pipes being connected to form tightly-closed joint.
- C. Use corrugated locking bands to field join pipes furnished with circumferential corrugations including pipe with helical corrugations having reformed circumferential corrugations on ends. Fit locking bands into minimum of one full circumferential corrugation of pipe ends being coupled

END OF SECTION

Section 02711

HOT MIX ASPHALT BASE COURSE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Foundation course of compacted mixture of coarse and fine aggregates, and asphalt binder.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for hot mix asphalt base is on a per ton basis.
2. Payment for hot mix asphalt base for transitions and base repairs is on a per ton basis.
3. No separate payment will be made for hot mix asphaltic base for temporary driveway, temporary detour pavement, temporary roadway shoulders, etc. Include payment in unit price for respective 02714 – Flexible Base Course for Temporary Driveways or 02741 – Asphaltic Concrete Pavement sections.
4. Measurement:
 - a. Match actual pavement area placed or replaced but no greater than maximum pavement replacement limits and thickness designated or shown on Drawings.
 - b. Include installed hot mix asphalt base course material that extends one foot beyond outside edge of pavement to be replaced, except where proposed pavement section shares common edge with existing pavement section.
 - c. Actual quantity for payment purpose as measured and calculated in this section shall not exceed the maximum volume-weight conversion rate of 105 pounds per square yard area per inch thickness.
5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. AASHTO T201 - Standard Specification for Kinematic Viscosity of Asphalts (Bitumens).
- B. AASHTO T202 - Standard Specification for Viscosity of Asphalt by Vacuum Capillary Viscometer.
- C. ASTM C 33 - Standard Specifications for Concrete Aggregate.
- D. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- E. ASTM C 136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- F. ASTM D 4402 - Standard Test Method for Viscosity Determination of unfilled Asphalt Using the Brookfield Thermal Apparatus.
- G. TxDOT Tex-106-E - Calculating the Plasticity Index of Soils.
- H. TxDOT Tex-126-E - Molding, Testing, and Evaluating Bituminous Black Base Material.
- I. TxDOT Tex-200-F- Sieve Analysis of Fine and Coarse Aggregates.
- J. TxDOT Tex-203-F - Sand Equivalent Test.
- K. TxDOT Tex-204-F - Design of Bituminous Mixtures.
- L. TxDOT Tex-207-F - Determining Density of Compacted Bituminous Mixtures.
- M. TxDOT Tex-208-F - Test for Stabilometer Value of Bituminous Mixtures.
- N. TxDOT Tex-227-F - Theoretical Maximum Specific Gravity of Bituminous Mixtures.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certificates that asphalt materials and aggregates meet requirements of

Paragraph 2.01, Materials.

- C. Submit proposed mix and test data for each type of base course in Work.
- D. Submit manufacturer's description and characteristics of mixing plant for approval.
- E. Submit manufacturer's description and characteristics of spreading and finishing machine for approval.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Coarse Aggregate:
 - 1. Use crushed gravel or crushed stone, or combination retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic, or other injurious material occurring either free or as coating on aggregate. Conform aggregate to ASTM C 33 except for gradation. Furnish rock or gravel with Los Angeles abrasion loss not to exceed 40 percent by weight when tested in accordance with ASTM C 131.
 - 2. Reclaimed asphalt pavement (RAP) or reclaimed Portland cement concrete pavement (RPCCP) are permitted as aggregates for hot mix asphalt base course if combined aggregate criteria, gradation, and mixture properties are met.
- B. Fine Aggregate: Sand or stone screenings, or combination thereof, passing No. 10 sieve. Conform aggregate to ASTM C 33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other deleterious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than 6 when tested by TxDOT Tex-106-E. Sand equivalent shall have minimum value of 45 when tested by TxDOT Tex-203-F.
- C. Composite Aggregate: Conform to following limits when graded in accordance with ASTM C 136. Provide either coarse or fine aggregate where designated on the Drawings.

GRADATION OF COMPOSITE AGGREGATE Percent Passing by Weight or Volume		
Sieve Size	Type A Coarse	Type B Fine Base
1 1/2"	98.0-100.0	-
1 1/4"	-	-
1"	78.0-94.0	98.0-100.0
3/4"	64.0-85.0	84.0-98.0
1/2"	50.0-70.0	-
3/8"	-	60.0 to 80.0
#4	30.0-50.0	40.0 to 60.0
#8	22.0-36.0	29.0-43.0
#30	8.0-23.0	13.0-28.0
# 50	3.0-19.0	6.0-20.0
#200	2.0-7.0	2.0-7.0
VMA % Minimum	12.0	13.0
*2 to 8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.		

- D. Asphalt Binder: Moisture-free homogeneous material meeting following requirements:

SPECIFICATION	PG 64 –22
Average 7-day Maximum Pavement Design Temperature, degrees	<64
Minimum Pavement Design Temperature, degrees C ^a	>-22
Original Binder	
Flash Point Temperature, T48, Minimum degrees C	230
Viscosity, ASTM D 4402, ^b Maximum 3 Pa.s (3000cP), Test Temperature, degrees C	135
Dynamic Shear, TP5; ^c G*/sine[], Minimum, 1.00kPaTest Temperature @ 10rad/sec, degrees C	64
Rolling Thin Film Oven (T240) or Thin Film Oven (T179) Residue	
Mass Loss, Maximum, %	- 1.00
Dynamic Shear, TP5; G*/sine[], Minimum, 2.20 kPa Test Temperature @ 10rad/sec, degrees C	64
Pressure Aging Vessel Residue (PPI)	
PAV Aging Temperature, degrees C ^d	100

SPECIFICATION	PG 64 – 22
Dynamic Shear, TP5; $G^*/\sin[\]$, Maximum, 5000 kPa Test Temperature @ 10rad/sec, degrees C	25
Physical Hardening ^e	Report
Creep Stiffness, TP1; ^f S, Maximum, 300 Mpa; m-value, Minimum, 0.300 Test Temperature @ 60 sec, degrees C	-12
Direct Tension, TP3; ^f Failure Strain, Minimum, 1.0%; Test Temperature @ 1.0 mm/min, degrees C	-12
Notes: ^a Pavement temperature can be estimated from air temperatures using algorithm contained in TxDOT testing procedures. ^b The requirement may be waived at discretion of Engineer if supplier warrants that asphalt binder can be adequately pumped and mixed at temperatures that meet applicable safety standards. ^c For quality control of unmodified asphalt cement production, measurement of viscosity of original asphalt cement may be substituted for dynamic shear measurements of $G^*/\sin[\]$ at test temperature where asphalt is Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary or rotational viscometry (AASHTO T 201 or T202). ^d The PAV aging temperature is based on simulated climatic conditions and is one of three	

- E. Reclaimed asphalt pavement (RAP) may be used at a rate no greater than 20 percent.

2.2 EQUIPMENT

- A. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuous mixtures meeting specifications. With exception of a drum mix plant, the plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins, and dust collectors.
- B. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:
1. Cold aggregate bins and proportioning device
 2. Dryer
 3. Screens

4. Aggregate weight box and batching scales
 5. Mixer
 6. Asphalt storage and heating devices
 7. Asphalt measuring devices
 8. Truck scales
- C. Bins: Separate aggregate into minimum of four bins to produce consistently uniform grading and asphalt content in completed mix. One cold feed bin per stockpile is required.

2.3 MIXES

- A. Employ certified testing laboratory to prepare design mixes.
1. Test in accordance with TxDOT Tex-126-E, TxDOT Tex-204-F, TxDOT Tex-208-F, and TxDOT Tex-227-F.
 2. Verify mixture design properties for plant-produced mixture. Demonstrate that asphalt plant is capable of producing mixture meeting design volumetric and stability requirements before placement begins.
- B. Density, Stability, and Air Voids Requirements. Select asphalt binder content for base courses to result in 3 to 5 percent air voids in laboratory molded specimens, while meeting minimum VMA requirement for selected mixture classification.

Percent Density		Percent	HVEEM Stability	Percent Asphalt Content	
<u>Min.</u>	<u>Max</u>	<u>Optimum</u>	Percent Not Less Than	<u>Min</u>	<u>Max</u>
94.5	97.5	96	35	3.5	7

PART 3 EXECUTION

3.1 PREPARATION

- A. Complete backfill of new utilities below future grade.
- B. Verify lines and grades are correct.
- C. Prepare subgrade in accordance with requirements of Section 02330 -

Embankment and Section 02315 - Roadway Excavation or Section 02336 - Lime Stabilized Subgrade and Section 02337 - Lime/Fly-Ash Stabilized Subgrade, and 02338 - Portland Cement Stabilized Subgrade. Subgrade preparation may also refer to Section 02321 - Cement Stabilized Sand or Section 02713 - Recycled Crushed Concrete Base Course.

- D. Correct subgrade deviations in excess of plus or minus 1/4 inch in cross section, or in 16 foot length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

3.2 PLACEMENT

- A. Place base when surface temperature taken in shade and away from artificial heat is above 40 degrees F and rising. Do not place asphalt base when temperature of surface to receive base course is below 50 degrees F and falling.
- B. Haul prepared and heated asphalt base mixture to project in tight vehicles previously cleaned of foreign material. Mixture shall be at temperature between 250 degrees F and 325 degrees F when laid.
- C. Place hot mix asphalt base course in compacted lifts no greater than 4 inches thick, unless permitted in writing by Engineer.
- D. Place courses as nearly continuously as possible. Place material with approved mechanical spreading and finishing machine of screeding or tamping type. Spread lifts to attain smooth course of uniform density to section, line, and grades as indicated on Drawings.
- E. In areas with limited space where use of paver or front-end loader is impractical, spread by hand and compact asphalt by mechanical means. Carefully place materials to avoid segregation of mix; do not broadcast material. Remove lumps that do not break down readily.

3.4 JOINTS

- A. Transverse Joints. Pass roller over unprotected ends of freshly laid mixture only when mixture has cooled. When work is resumed, cut back placed material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.
- B. Existing pavement. When new asphalt is laid against existing asphalt pavement, saw cut existing asphalt to full depth creating vertical face. Clean joint and apply tack coat before placement.

3.5 COMPACTION

- A. Construct test strip to identify correct type, number, and sequence of rollers necessary to obtain specified in-place density or air-voids. Prepare test strip at least 500 feet in length, comparable to placement and compaction conditions for Project.
- B. Begin rolling while pavement is still hot and as soon as it will bear roller without undue displacement or hair line cracking. Keep wheels properly moistened with water to prevent adhesion of surface mixture. Do not use excessive water; do not use petroleum by-products.
- C. Compact surface thoroughly and uniformly with power-driven equipment capable of obtaining required compaction. Obtain subsequent compression by starting at side and rolling longitudinally toward center of pavement, overlapping on successive trips by at least one-half width of rear wheels. Make alternate trips slightly different in length. Continue rolling until no further compression can be obtained and rolling marks are eliminated. Complete rolling before mat temperature drops below 175 degrees F.
- D. Along walls, curbs, headers, similar structures, and in locations not accessible to rollers, compact mixture thoroughly with lightly oiled tamps.
- E. Compact base course to a minimum density of 91 percent (TxDOT Tex-227-F).

3.6 TOLERANCES

- A. Pavement Repairs.
 - 1. Furnish templates for checking surface of finished sections. Maximum deflection of templates, when supported at center, shall not exceed 1/4 inch.
 - 2. Completed surface, when tested with 10-foot straight edge laid parallel to center line of pavement, shall show no deviation in excess of 1/4 inch in 10 feet. Correct surface not meeting this requirement.

3.7 FIELD QUALITY CONTROL

- A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.
- B. For in-place depth and density, take minimum of one core at random locations for each 1000 feet of single lane pavement. On a 2-lane pavement, take samples at random every 500 feet from alternating lanes. Take cores for parking lots every 500 square yards of base to determine in-place depth and density. If cul-de sac or streets are less than 500 feet, minimum of 2 cores (one per lane) will be procured. On small projects, take a minimum of two cores for each day's placement. For first days placement and prior to coring, minimum of 5 nuclear

gauge readings will be performed at each core location to establish correlation between nuclear gauge (wet density reading) and core (bulk density). This process will continue for each day's placement until engineer determines that a good bias has been established for that nuclear gauge.

- C. Determine in-place density in accordance with TxDOT Tex-207-F and Tex-227-F from cores or sections of asphaltic base located near each core. Other methods of determining in-place density, which correlate satisfactorily with results obtained from roadway specimens, may be used when approved by Engineer.
- D. Request, at option, three additional cores within a 5-foot radius of core indicating nonconforming in-place depth at no additional cost to Authority. In-place depth at these locations shall be average depth of four cores.
- E. Fill cores and density test sections with new compacted asphalt base or cold patch material.

3.8 NONCONFORMING PAVEMENT

- A. Re-compact and retest nonconforming street sections not meeting surface test requirements. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute. Retesting is at no cost to the Authority.
- B. Remove and replace areas of asphalt base found deficient in thickness by more than 10 percent. Remove and replace areas of asphalt base found deficient in density. Use new asphalt base of thickness shown on Drawings.
- C. Replace or correct nonconforming pavement sections at no additional cost to Authority.

3.9 PROTECTION

- A. Do not open base to traffic until 12 hours after completion of rolling, or as shown on Drawings.
- B. Maintain asphalt base in good condition until completion of Work.
- C. Repair defects immediately by replacing base to full depth.

END OF SECTION

Section 02712

CEMENT STABILIZED BASE COURSE

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Foundation course of cement stabilized crushed stone.
- B. Foundation course of cement stabilized bank run gravel.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for cement stabilized base course is on square yard basis. Separate pay items are used for each different required thickness of base course.
 - 2. No payment will be made for asphaltic seal cure. Include cost in unit price for cement stabilized base course.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
 - 4. Refer to Paragraph 3.9, Unit Price Adjustment.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in Los Angeles Machine.
- B. ASTM C 150 - Standard Specification for Portland Cement.
- C. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft³ (600kN kN-m/m³).
- D. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

- E. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- F. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- G. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- H. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- I. TxDOT Tex-120-E - Soil-Cement Testing.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit samples of crushed stone, gravel, and soil binder for testing.
- C. Submit manufacturer's description and characteristics for pug mill and associated equipment, spreading machine, and compaction equipment for approval.

1.5 TESTS

- A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.
- B. Perform tests and analysis of aggregate and binder materials in accordance with ASTM D 1557 and ASTM D 4318.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Make stockpiles from layers of processed aggregate to eliminate segregation of materials. Load material by making successive vertical cuts through entire depth of stockpile.
- B. Store cement in weatherproof enclosures. Protect from ground dampness.

PART 2 PRODUCTS

2.1 CEMENT

- A. ASTM C 150 Type I; bulk or sacked.

2.2 WATER

- A. Clean, clear; and free from oil, acids, alkali, or vegetable matter.

2.3 AGGREGATE

- A. Crushed Stone: Material retained on No. 40 Sieve meeting following requirements:
1. Durable particles of crusher-run broken limestone, sandstone, or granite obtained from approved source.
 2. Los Angeles abrasion test percent of wear not to exceed 40 when tested in accordance with ASTM C 131.
- B. Gravel: Durable particles of bank run gravel or processed material.
- C. Soil Binder: Material passing No. 40 Sieve meeting following requirements when tested in accordance with ASTM D 4318:
1. Maximum Liquid limit: 35.
 2. Maximum Plasticity index: 10.
- D. Mixed aggregate and soil binder shall meet the following requirements:
1. Grading in accordance with TxDOT Tex-101-E and Tex-110-E within the following limits:

Sieve	Percent Retained			
	Crushed Stone 0 to 10	Processed G. 1 0 to 5	Gravel G. 2 -	Bank run Gravel 0 to 5
1 3/4 inch				
1/2 inch	-	-	0	-
No. 4	45 to 75	30 to 75	15 to 35	30 to 75
No. 40	55 to 80	60 to 85	55 to 85	65 to 85

2. Obtain prior permission from Engineer for use of additives to meet above requirements.

2.4 ASPHALT SEAL CURE

- A. Cutback Asphalt: MC30 conforming to requirements of Section 02742 - Prime

Coat.

- B. Emulsified Petroleum Resin: EPR-1 Prime conforming to requirements of Section 02742 - Prime Coat.

2.5 MATERIAL MIX

- A. Design mix for minimum average compressive strength of 200 psi at 48 hours using TxDOT Tex-120-E unconfined compressive strength testing procedures. Provide minimum cement content of 1 1/2 sacks, weighing 94 pounds each, per ton of mix.
- B. Increase cement content when average compressive strength of tests on field samples fall below 200 psi. Refer to Part 3 concerning field samples and tests.
- C. Mix in stationary pug mill equipped with feeding and metering devices for adding specified quantities of base material, cement, and water into mixer. Dry mix base material and cement sufficiently to prevent cement balls from forming when water is added.
- D. Resulting mixture shall be homogeneous and uniform in appearance.

2.6 SOURCE QUALITY CONTROL

- A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.
- B. Perform testing for unconfined compressive strength by TxDOT Test Method Tex-120-E as follows:
 - 1. Mold three samples each day or for each 300 tons of production.
 - 2. Compressive strength shall be average of three tests for each production lot.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.2 PREPARATION

- A. Complete backfill of new utilities below future grade.
- B. Prepare subgrade in accordance with requirements of Section 02330 - Embankment and Section 02315 - Roadway Excavation.
- C. Correct subgrade deviations in excess of plus or minus 1/4 inch in cross section or in 16-foot length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
- D. Prepare sufficient subgrade in advance of base course for efficient operations.

3.3 PLACEMENT

- A. Do not mix and place cement stabilized base when temperature is below 40 degrees F and falling. Place base when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.
- B. Place material on prepared subgrade in uniform layers to produce thickness indicated on Drawings. Depth of layers shall not exceed 6 inches.
- C. Spread with approved spreading machine. Conduct spreading so as to eliminate planes of weakness or pockets of non-uniformly graded material resulting from hauling and dumping operations.
- D. Provide construction joints between new material and stabilized base that has been in place 4 hours or longer. Joints shall be approximately vertical. Form joint with temporary header or make vertical cut of previous base immediately before placing subsequent base.
- E. Use only one longitudinal joint at center line under main lanes and shoulder unless shown otherwise on Drawings. Do not use longitudinal joints under frontage roads and ramps unless indicated on Drawings.
- F. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Secure firm bond between reinforcement and base.

3.4 COMPACTION

- A. Start compaction as soon as possible but not more than 60 minutes from start of moist mixing. Compact loose mixture with approved tamping rollers until entire depth is uniformly compacted. Do not allow stabilized base to mix with underlying material.
- B. Correct irregularities or weak spots immediately by replacing material and recompacting.

- C. Apply water to maintain moisture between optimum and 2 percent above optimum moisture as determined by ASTM D 698. Mix in with spiked tooth harrow or equal. Reshape surface and lightly scarify to loosen imprints made by equipment.
- D. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.
- E. Finish by blading surface to final grade after compacting final course. Seal with approved pneumatic tired rollers which are sufficiently light to prevent surface hair line cracking. Rework and recompact at areas where hair-line cracking develops.
- F. Compact to minimum density of 95 percent of maximum dry density at moisture content of treated material between optimum and 2 percent above optimum as determined by ASTM D 1557, unless otherwise indicated on Drawings.
- G. Maintain surface to required lines and grades throughout operation.

3.5 CURING

- A. Moist cure for minimum of 7 days before adding pavement courses. Restrict traffic on base to local property access. Keep subgrade surface damp by sprinkling.
- B. If indicated on Drawings, cover base surface with curing membrane as soon as finishing operation is complete. Apply with approved self-propelled pressure distributor at following rates, or as indicated on Drawings:
 - 1. MC30: 0.1 gallon per square yard.
 - 2. EPR-1 Prime: 0.15 gallon per square yard.
- C. Do not use cutback asphalt during period of April 16 to September 15.

3.6 TOLERANCES

- A. Smooth and conform completed surface to typical section and established lines and grades.
- B. Top surface of base course: Plus or minus 1 1/4 inch in cross section, or in 16 foot length.

3.7 FIELD QUALITY CONTROL

- A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.

- B. Take minimum of one core at random locations per 1000 linear feet per lane of roadway or 500 square yards of base to determine in-place depth.
- C. Request additional cores in vicinity of cores indicating nonconforming in-place depths at no extra cost to Authority. When average of tests fall below required depth, place additional material and compact at no additional cost to Authority.
- D. Perform compaction testing in accordance with ASTM D 698 or ASTM D 2922 and ASTM D 3017 at randomly selected locations. Remove and replace areas that do not conform to compaction requirements at no additional cost to Authority.
- E. Fill cores and density test sections with new compacted cement stabilized base.

3.8 NONCONFORMING BASE COURSE

- A. Remove and replace areas of base course found deficient in thickness by more than 10 percent, or that fail compressive strength tests, with cement-stabilized base of thickness shown on Drawings.
- B. Replace nonconforming base course sections at no additional cost to Authority.

3.9 UNIT PRICE ADJUSTMENT

- A. Make unit price adjustments for in-place depth determined by cores as follows:
 - 1. Adjusted unit price shall be ratio of average thickness as determined by cores to thickness bid upon, times unit price.
 - 2. Apply adjustment to lower limit of 90 percent and upper limit of 100 percent of unit price.

3.10 PROTECTION

- A. Maintain stabilized base in good condition until completion of Work. Repair defects immediately by replacing base to full depth.
- B. Protect asphalt membrane, when used, from being picked up by traffic. Membrane may remain in place when proposed surface courses or other base courses are to be applied.

END OF SECTION

Section 02713

RECYCLED CRUSHED CONCRETE BASE COURSE

PART 1 GENERAL

1.01 SUMMARY

This Section includes recycled crushed concrete base (RCCB) course.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for RCCB is on a per square yard basis, furnished and compacted in place.
2. Payment for RCCB for transitions and base repairs is on a per square yard basis.
3. Payment for RCCB for temporary driveway, roadway shoulders, and elsewhere shown on Plans is on a per square yard basis.
4. Refer to Section 01270 – “Measurement and Payment” for unit price procedures

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM C 150 - Standard Specification for Portland Cement.
- B. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- C. TxDOT Tex-106-E - Calculating the Plasticity Index of Soils.
- D. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- E. TxDOT Tex-113-E - Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials.
- F. TxDOT Tex-115-E - Field Method for Determining In-place Density of Soils and Base Materials.

- G. TxDOT Tex-120-E - Soil-Cement Testing

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 – “Submittal Procedures”.
- B. Submit representative samples of crushed concrete for testing.
- C. Submit weight tickets, certified by supplier, for each delivery of recycled crushed concrete, gravel, and soil binder.
- D. Submit manufacturer's description and characteristics for pug mill and associated equipment, mixer trucks, spreading and compaction equipment for approval.

1.05 RELATED REQUIREMENTS

- A. Section 01270 – “Measurement and Payment”
- B. Section 01330 – “Submittal Procedures”
- C. Section 01452 – “Inspection Services”
- D. Section 01454 – “Testing laboratory Services”
- E. Section 02315 – “Roadway Excavation”
- F. Section 02330 – “ Embankment”
- G. Section 02336 – “Lime-Stabilized Subgrade”
- H. Section 02337 – “Lime/Fly-Ash Stabilized Subgrade”
- I. Section 02338 – “Portland Cement Stabilized Subgrade”
- J. Section 02742 – “Prime Coat”

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide materials from stockpiles that are protected during storage from contaminants detrimental to concrete base.
- B. Load material from same area of stockpile to maintain uniformity of each successive delivery to Project site.
- C. Store cement in weatherproof enclosures. Protect from ground dampness.

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. System Description

1. Provide RCCB with following performance:
 - a. Minimum 7 percent cement.
 - b. Minimum compressive strength: 650 psi at 14 days following TxDOT Tex-120-E.
 - c. Prepare concrete product in on-site or off-site pug mill, or in on-site or off-site portable concrete mixer.
2. Preliminary Design: Prepare preliminary mix with minimum cement to crushed concrete ratios of 5 percent by dry mass of materials.
 - a. Designate source of concrete for crushing. Follow Section 01454 – “Testing Laboratory Services” for tests of concrete from source.
 - b. Results of laboratory and compression tests will be used by the Engineer to select final mix design

B. Portland Cement

ASTM C 150 Type I, II, or III; bulk or sacked.

C. Water

Potable.

D. Aggregate

1. Recycled Crushed Concrete: Material retained on No. 40 Sieve, and durable coarse particles of crusher-run reclaimed cured Portland cement concrete, obtained from approved source. Organic material is prohibited.
 - a. The crushed concrete shall be substantially free of foreign matter including but not limited to asphalt, base, and dirt.
 - b. Obtain Engineer’s written approval, prior to crushing salvaged concrete.
2. Soil Binder (classified below): Meeting following requirements when tested following TxDOT Tex-106-E:
 - a. Maximum liquid limit: 35
 - b. Maximum plasticity index: 10

3. Mixed Aggregate and Soil Binder: Grading following TxDOT Tex-101-E and Tex-110-E within following limits:

Sieve	Percent Crushed Concrete Retained
1¾ inch	0 to 10
No. 4	45 to 75
No. 40	55 to 80; classified as Soil Binder

- a. Obtain prior permission from Engineer for use of additives to meet above requirements.
- b. Bank sand may be added to mix at pug mill with permission of Engineer.

E. Asphaltic Seal Cure

1. Acquire written approval from Engineer before curing and before proceeding with curing.
2. Use following as option to curing by sprinkling:
 - a. Cut-back asphalt: MC30 following Section 02742 – “Prime Coat”.
 - b. Emulsified petroleum resin: EPR-1 Prime following Section 02742 – “Prime Coat”.

F. Material Mix

1. Design mix for minimum compressive strength of 650 psi at 14 days following TxDOT Tex-120-E unconfined compressive strength.
2. Cement Ratio: Follow Paragraph 2.02A. Increase cement content in two percent steps up to 9 percent maximum when compressive strength of design mix samples fail TxDOT Tex-120-E test.

G. Mixing Equipment

Mix following paragraph 2.02A, with metering devices adding specified quantities of crushed concrete, cement, and water into mixer. Dry mix crushed concrete and cement prior to adding water. Produce homogeneous and uniformly mixed product.

2.03 FABRICATION (NOT USED)

2.04 SOURCE QUALITY CONTROL

- A. Test following Section 01454 – “Testing Laboratory Services”.

- B. When directed by Engineer, test for unconfined compressive strength following Test Method TxDOT Tex-120-E as follows:

1. Mold minimum of three samples each day or for each 500 tons of production or one for each day.
2. Compressive strength: average of 3 specimens for each sample lot.

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

3.02 PREPARATION

- A. Examination

1. Follow Section 01452 – “Inspection Services”.
2. Verify buried utility work is complete.
3. Verify lime treatment of base is complete.
4. Verify subgrade is ready to support imposed loads.
5. Verify flatwork, foundations, projecting reinforcement and similar Work interfacing with base is in place.
6. Verify lines and grades are correct.

- B. Complete backfill of new utilities below future grade.

- C. Prepare subgrade in accordance with requirements of Section 02330 – “Embankment” and Section 02315 – “Roadway Excavation”, or Section 02336 – “Lime Stabilized Subgrade” and Section 02337 – “Lime-Fly Ash Stabilized Subgrade” and Section 02338 – “Portland Cement Stabilized Subgrade”.

- D. Correct subgrade deviations in excess of plus or minus ¼ inch in cross section, or in 16 foot length by loosening, adding or removing material, reshaping and recompact by sprinkling and rolling.

- E. Prepare sufficient subgrade in advance of base course for efficient operations.

- F. Have sufficient products and equipment on hand to expeditiously apply base.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

- A. Mixing

Maintain moisture content of between optimum and 5 percent above optimum.

B. Placement

1. Place mixture with approved spreading equipment. Spread to eliminate planes of weakness or pockets of non-uniformly graded material resulting from hauling and dumping operations.
2. Provide approximately vertical construction joints between fresh base and base-in-place 4 hours or longer. Form joint with temporary header or make vertical cut of in-place base immediately before placing fresh base.
3. Make cold joints at center line of head-to-head parking stalls.
4. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Provide proper bond between reinforcement and base.
5. Transverse and longitudinal joints shall be vertical.
6. Unless noted otherwise, place recycled crushed concrete base in courses not to exceed 8 inches in depth. All courses shall be placed on same working day unless approved by Engineer. Construction joints between new base and base previously placed shall be wetted and coated with dry cement prior to addition of new base.
7. Complete finishing operations within period of 6 hours after cement is added to base materials

C. Compaction

1. Start compaction maximum 3 hours after start of mixing. Compact loose mixture with approved tamping rollers until entire depth is uniformly compacted. Do not allow base to mix with underlying material.
 - a. Do not rework uncompacted material that has set up for more than 30 minutes.
 - b. Complete placement and compaction work within 6 hours from start of moist mixing.
2. Correct irregularities or weak spots immediately by replacing material and recompacting.
3. Apply water to maintain moisture between optimum and 5 percent above optimum moisture.
4. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.

5. Finish by blading surface to final grade after compacting final course. Seal with approved pneumatic tired rollers or flat wheel rollers which are sufficiently light to prevent surface hair line cracking.
6. Compact to minimum density of 95 percent of dry density, following TxDOT Tex-113-E, at moisture content of treated material between optimum and 5 percent above optimum.
7. Test roadway base course compaction in accordance with TxDOT Tex-115-E.
8. Maintain surface to required lines and grades throughout operation

D. Curing

1. Moist cure for minimum of 72 hours before adding pavement courses.
2. Use sprinkling or, at option, apply following curing membrane as soon as initial set begins, using approved light-weight self-propelled pressure distributor:
 - a. MC30: 0.1 gallon per square yard.
 - b. EPR-1 Prime: 0.15 gallon of asphalt residual per square yard.
3. Do not use cut-back asphalt during period of April 16 through September 15

E. Tolerances

1. Completed Surface: Smooth and conform to typical section and established lines and grades.
2. Top Surface of Base Course: Plus or minus ¼ inch in cross section or in 16 foot length.

3.04 REPAIR/RESTORATION (NOT USED)

3.05 FIELD QUALITY CONTROL

- A. Test following Section 01454 – “Testing Laboratory Services”.
- B. Perform compaction tests following TxDOT Tex-113-E at randomly selected locations. Remove and replace areas failing compaction requirements at no additional cost.

3.06 – 3.07 NOT USED

3.08 DEMONSTRATION / TESTING AND INSPECTION

- A. Follow Section 01454 – “Testing Laboratory Services”.

- B. Test and analyze aggregate and binder products following TxDOT Tex-110-E

3.09 PROTECTION

- A. Maintain base in proper condition until surface is placed. Surface must be placed within 14 days after final mixing and compaction unless otherwise approved by Engineer. Repair unacceptable base course immediately by replacing base to full depth.
- B. Curing membrane may remain in place at areas where surface courses or other base courses are applied.
- C. Prevent construction traffic on base for minimum 3 days. Light vehicles, used to maintain proper cure, are permitted on base after initial set or as permitted by Engineer.

3.10 SCHEDULES (NOT USED)

END OF SECTION

SECTION 02714

FLEXIBLE BASE COURSE FOR TEMPORARY DRIVEWAYS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Foundation course of crushed concrete or stone.

1.02 MEASUREMENT AND PAYMENT

A. UNIT PRICES

1. Measurement for flexible base course payment is on each driveway basis. To maintain access or temporary driveway, separate measurement will be made for each different type of driveway (residential, commercial, or custom properties) or as identified on the construction drawings.
 2. Payment limits for temporary driveways are based upon the width of the driveway access (not to exceed 12-feet for residential, 24-feet for commercial, or custom dimensioned properties) and the length from permanent or temporary roadway to the remaining permanent driveway or street right-of-way, as necessary to maintain access to properties.
 3. No separate payment will be made for flexible base course for temporary roads, detour pavements, and shoulder under this Section unless it is included as an extra unit bid and as approved for payment by the Engineer. Flexible base course for temporary driveways or access if included under the extra unit bid item is on a cubic yard basis.
 4. Temporary driveways will be paid only once per driveway location shown to be replaced on the drawing and payment shall be made based upon actual installation.
 5. Refer to Section 01270 - Payment Procedures for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

- A. ASTM D1556 - Density of Soil in Place by the Sand-Cone Method.
- B. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft³).

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- C. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- D. ASTM D361 - Test Method for Water Content of Soils and Rock in Place by Nuclear Methods (shallow depth).
- E. ASTM D3017 - Test Method for Water Content of Soils and Rock in Place by Nuclear Methods.
- F. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- G. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
- H. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.

1.04 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 - Submittals Procedures.
- B. Submit samples of flexible base course and soil binder for testing.

1.05 TESTS

- A. Tests and analysis of soil materials will be performed in accordance with ASTM C131, ASTM D 698, ASTM D 4318, Tex-101-E, and Tex-110-E under provisions of Section 01454 - Testing Laboratory Services.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide materials from stockpiles that are protected during storage from contaminants that would be detrimental to the flexible base course.
- B. Load materials from same area of stockpile to maintain uniformity of each successive delivery to the project site.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Crushed Stone or Concrete: Material retained on the No. 40 sieve meeting the following requirements:
 - 1. Durable particles of crusher-run broken limestone, crushed concrete, crushed sandstone, or granite obtained from an approved source.

- B. Soil Binder: Material passing the No. 40 sieve meeting the following requirements when tested in accordance with ASTM D4318:
1. Maximum Liquid Limit: 40
 2. Maximum Plasticity Index: 12
 3. Maximum Lineal Shrinkage: 7 (when calculated from volumetric shrinkage at liquid limit).
- C. Mixed Materials shall meet the following requirements:
1. Minimum compressive strength of 35 psi at 0 psi lateral pressure and 175 psi at 15 psi lateral pressure using triaxial testing procedures.
 2. Grading in accordance with Tex-101-E and Tex-110-E within the following limits:

Sieve	Percent Retained
1-3/4 inch	0 to 10
No. 4	45 to 75
No. 40	60 to 85

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.02 PREPARATION

- A. Complete backfill of new utilities below future grade.
- B. Prepare subgrade in accordance with requirements of Section 02315 – Roadway Excavation or Sections 02336 - Lime Stabilized Subgrade and 02337 - Lime/Fly-ash Stabilized Subgrade.
- C. Correct subgrade deviations in excess of plus or minus 1/2 inch in cross section, or in 16 foot length by loosening, adding or removing material, reshaping and re-compacting by sprinkling and rolling.
- D. Prepare sufficient subgrade in advance of base course operations.

3.03 PLACEMENT

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- A. Spread and shape in lifts to compacted thickness not to exceed 6 inches in depth. Complete spreading, shaping, and compacting on same day material is deposited.
- B. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Secure a firm bond between reinforcement and base.
- C. Start rolling operations as soon as possible after placement. Use sheepfoot, steel, or pneumatic rollers as approved. Roll longitudinally with subgrade starting from sides. Overlap successive strips by one-half width of each rear wheel.
- D. Maintain moisture between optimum and 3 percent above optimum moisture.
- E. Compact to 95 percent of Proctor density in accordance with ASTM D698, unless otherwise indicated on the Drawings.
- F. Finish to grade and compact lift before placing successive lift.
- G. Maintain shape by grading throughout operation.
- H. Provide total thickness indicated on Drawings.

3.04 TOLERANCES

- A. Completed surface shall be smooth and conform to typical section and established lines and grades.

3.05 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Compaction Testing will be performed in accordance with ASTM D698 or ASTM D2922 and ASTM 3017 at a random location near each depth determination core. Rework and re-compact areas that do not conform to compaction requirements.

3.06 PROTECTION

- A. Sprinkle to prevent excessive loss of moisture.
- B. Restrict construction traffic on finished base to equipment required to complete the work.

END OF SECTION

Section 02716 (Large Diameter)
CEMENT STABILIZED SAND BASE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Cement stabilized sand base material.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for work under this section will be on a square yard basis for the thickness shown on Drawings. Limits of measurement will match actual pavement replaced, but no greater than the maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed cement stabilized sand base course material that extends 1 foot beyond outside edge of pavement to be replaced, except where proposed pavement section shares a common longitudinal or transverse edge with existing pavement section. No pavement will be made for cement stabilized sand base in areas beyond these limits.
 - 2. A price reduction for deficient thickness or strength will be applied in accordance with paragraph 3.08.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

- A. ASTM D558 - Standard Test Methods for Moisture-Density Relations of Soil-Cement Mixtures.

1.04 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit material qualification and mix design tests to include:
 - 1. Three series of tests of sand or fine aggregate material from proposed source. Test procedures are defined in Paragraph 2.01.
 - 2. Three moisture-density relationship tests prepared using the material qualified by the tests of Paragraph 1.04 B.1. Test blends of fine aggregate from crushed concrete and bank run sand at ratio to be used for mix design testing.
 - 3. Mix design report to meet design requirements of Paragraph 2.01. Include compressive strength tests after 48-hours and 7 days curing.
- C. Submit source of cement-sand material.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Conform to requirements of Section 02321 - Cement Stabilized Sand.

2.02 MIXING MATERIALS

- A. Conform to requirements of Section 02321 - Cement Stabilized Sand.

PART 3 E X E C U T I O N

3.01 FIELD QUALITY CONTROL

- A. Conform to requirements of Section 02321 -Cement Stabilized Sand for performance, testing and adjustment for deficient strength.
- B. Material not placed, compacted and finished within 4 hours after mixing shall be rejected.

3.02 PREPARATION OF SUBGRADE

- A. After excavation and/or fill is made to subgrade lines, remove soft or undesirable material and replace with material as specified under Section 02317 - Excavation and Backfill for Utilities. Grade and shape subgrade required to construct cement-stabilized sand base in conformance with lines, grades, thickness and typical cross section shown on Drawings.
- B. Compact subgrade material as specified in Section 02317 - Excavation and Backfill for Utilities.

3.03 PLACING

- A. Do not exceed percentage of moisture in soil subgrade at time of cement-stabilized sand base placement that permits uniform and intimate cement sand curing during placement operations. Do not exceed specified optimum moisture content for surrounding soil.
- B. Place cement-stabilized base in uniform layers to produce depth indicated on Drawings. Place material in a single layer for depth of 6 inches or less. Place no single layer thicker than 6 inches or less than 3 inches for depth greater than 6 inches.
- C. Provide material on dry side of optimum moisture content during compaction but sufficient for hydration.
- D. Make vertical construction joints between new material and material placed for more than 4 hours. Form plane of joint by a header removed immediately prior to placing new base, or cut base placed first to a vertical edge immediately prior to placing new base.
- E. Do not place base when air temperature is below 40 Degrees F and falling. Place when temperature is above 35 Degrees F and rising. Take temperature in shade and away from artificial heat.

3.04 COMPACTION

- A. Roll loose mixture with tamping rollers in addition to plate compactors or tandem rollers. Compact with mechanical hand tampers in places inaccessible to roller
- B. Compact to 95 percent ASTM D558, unless otherwise specified.
- C. Reconstruct sections when moisture content of uncompacted material exceeds amount required for proper hydration of cement.

3.05 FINISHING

- A. Finish surface to grade by blading and seal with pneumatic or flat wheel rollers after final course is compacted. Other means providing a dense, uniform surface and avoiding compaction planes are permitted.
- B. Correct any deviation from plan surface in excess of 1/4 inch in cross section and in length of 16 feet measured longitudinally prior to paving. Correct irregularities or weak spots by removing full depth of affected areas. Replace with suitable material as required. Reshape and compact.
- C. Maintain moisture content of surface material within 2 percent of optimum moisture. Proceed with surface compaction and finishing to produce a smooth, closely knit surface, free of cracks, ridges or loose material. Conform to crown, grade and line shown on Drawings, or as required to ensure proper drainage of pavement.

3.06 CURING

- A. Protect finished surface against rapid drying by maintaining a moist condition. Sprinkle for not less than 3 days or until surface or pavement is placed.

3.07 TRAFFIC AND MAINTENANCE

- A. Completed section of cement-stabilized sand base may be opened to local traffic and construction equipment after curing period, provided base material has hardened sufficiently to prevent marring or distorting surface by equipment or traffic.
- B. Maintain cement-stabilized base in good condition until pavement replacement has been completed and accepted. Immediately repair defects, as often as needed to keep area intact. Repair cement-stabilized base to full depth by replacement. Do not repair by adding a thin surface layer to damaged part.

3.08 ADJUSTMENT FOR DEFICIENT BASE THICKNESS AND STRENGTH

- A. Construct base to thickness and typical section shown on Drawings. Where base does not conform:
 - 1. Authority may core drill base prior to final acceptance. Cores will be drilled full thickness of section. At least three core thicknesses will be averaged to determine base thickness.
 - 2. A base within 1/2 inch of required thickness will be considered as satisfactory.

3. A base thickness between 1/2 inch less and 1-1/2 inches less than required thickness will be considered deficient. Adjusted unit price will be used in payment.
 - a. Adjusted unit price will bear same ratio to unit price as square of actual average thickness of base bears to square of thickness shown.
 - b. Length of area of such deficient thickness will be determined by additional cores taken at 10-foot intervals in both directions until cores are obtained which are at least that required thickness less 2 inch.
 - c. Width of deficiency will be entire width of base as placed in one operation within length as determined above.
 4. No payment will be made for base found more than 1-1/2 inches deficient. Length of unsatisfactory area will be determined by additional cores at 10-foot intervals in both directions until cores are obtained which are required thickness less 1/2 inch. Width will be entire base as placed in one operation within length determined as above. Remove and replace such base with base of specified thickness.
 5. No additional payment over unit price will be made for thickness exceeding that required.
 6. Contractor responsible for cost of cores taken to define limits of deficient base thickness.
- B. Refer to Section 02321 - Cement Stabilized Sand, paragraph 3.03 for payment adjustment for deficient strength.

END OF SECTION

Section 02741

ASPHALTIC CONCRETE PAVEMENT

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Surface course of compacted mixture of coarse and fine aggregates and asphaltic binder.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for hot-mix asphalt concrete pavement is on a per ton basis. Separate pay items are used for each different required thickness of pavement.
2. Payment for hot-mix asphalt concrete pavement includes payment for associated work performed in accordance with Section 02743 - Tack Coat.
3. Payment for pavement repair or pavement replacement for utility projects is on a square yard basis and includes surface and base materials in accordance with Section 02951 – Pavement Repairs and Restoration.
4. Payment for temporary detour pavement or temporary roadway and shoulder is on a square yard basis and includes surface and base materials, associated grading, maintenance and removal as well as restoration of ditches.
5. Payment for speed humps is on linear foot basis, and includes milling of existing pavement, tack coat, and placement and compaction of asphalt. Measurement of speed hump is along length of 12 foot wide speed hump, measured transverse to centerline of road. Separate payment is made for thermoplastic markings applied to speed hump.
6. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 33 - Standard Specification for Concrete Aggregates.
- B. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- C. TxDOT Tex-106-E - Calculating the Plasticity Index of Soils
- D. TxDOT Tex-126-E - Molding, Testing, and Evaluating Bituminous Black Base Material.
- E. TxDOT Tex-200-F - Sieve Analysis of Fine and Course Aggregates.
- F. TxDOT Tex-203-F - Sand Equivalent Test.
- G. TxDOT Tex-204-F - Design of Bituminous Mixtures.
- H. TxDOT Tex 206-F - Compacting Test Specimens of Bituminous Mixtures.
- I. TxDOT Tex-207-F - Determining Density of Compacted Bituminous Mixtures.
- J. TxDOT Tex-208-F - Test for Stabilometer Value of Bituminous Mixtures.
- K. TxDOT Tex-217-F - Determining Deleterious Material and Decantation Test for Coarse Aggregates.
- L. TxDOT Tex-227-F - Theoretical Maximum Specific Gravity of Bituminous Mixtures.
- M. TxDOT Tex-530-C - Effect of Water on Bituminous Paving Mixtures.
- N. TxDOT Tex-531-C - Prediction of Moisture Induced Damage to Bituminous Paving Materials Using Molded Specimens.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certificates that asphalt materials and aggregates meet requirements of Paragraph 2.1, Materials.
- C. Submit proposed design mix and test data for surface course.
- D. Submit manufacturer's description and characteristics of spreading and finishing machine for approval.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Coarse Aggregate: Use gravel, crushed stone, or combination thereof, that is retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic or other injurious matter occurring either free or as coating on aggregate. Use aggregate conforming to ASTM C 33 except for gradation. Furnish rock or gravel with Los Angeles abrasion loss not to exceed 40 percent by weight when tested in accordance with ASTM C 131.
1. Aggregate by weight shall not contain more than 1.0 percent by weight of fine dust, clay- like particles, or silt when tested in accordance with Tex-217-F, Part II.
- B. Fine Aggregate: Sand, stone screenings or combination of both passing No. 10 sieve. Use aggregate conforming to ASTM C 33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other injurious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than 6 when tested by TxDOT Tex- 106-E. Sand equivalent shall have minimum value of 45 when tested by TxDOT Tex-203-F.
- C. Composite Aggregate: Conform to following limits when graded in accordance with TxDOT Tex-200-F. Use type specified on Drawings:

GRADATION OF COMPOSITE AGGREGATE		
SIEVE SIZE	PERCENT PASSING	
	Course Surface (TxDOT Type C)	Fine Surface (TxDOT Type D)
-	-	-
3/4 "	95 to 100	-
1/2"	-	98.0-100.0
3/8"	70.0-85.0	85.0-100.0
#4	43 to 63	50.0 to 70.0
#8	32.0-44.0	35.0-46.0
#30	14.0-28.0	15.0-29.0
# 50	7.0-21.0	7.0-20.0
#200	2.0-7.0	2.0-7.0
VMA % minimum	14.0	15.0
* 2 to 8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.		

- D. Asphalt Binder: Moisture-free homogeneous material which will not foam when heated to 347 F, meeting the following requirements.

PERFORMANCE GRADED BINDER	
CRITERIA / TEST	PERFORMANCE GRADE (PG64-22)
Average 7-day Maximum Pavement Design Temperature, C	< 64
Minimum Pavement Design Temperature, C	> -22
ORIGINAL BINDER	
Flash Point Temperature, T48; Minimum C	230
Viscosity, ASTM D 4402; Maximum, 3Pa*s (3000 cP) Test Temperature, C	135
Dynamic Shear, TP5; $G^*/\sin[\]$, Minimum, 1.00 kPa Test Temperature @ 10 rad/sec., C	64
ROLLING THIN FILM OVEN (T240) OR THIN FILM OVEN (T179) RESIDUE	
Mass Loss, Maximum , %	1.00
Dynamic Shear, TP5; $G^*/\sin[\]$, Minimum, 2.20 kPa Test Temperature @ 10 rad/sec., C	64
PRESSURE AGING VESSEL RESIDUE (PP1)	
PAV Aging Temperature, C	100
Dynamic Shear, TP5; $G^*/\sin[\]$, Minimum, 5000 kPa Test Temperature @ 10 rad/sec., C	25
Physical hardening	Report
Creep Stiffness, TP1; S, Maximum, 300 Mpa -value, Minimum, 0.300 Test Temperature @ 60 sec., C	-12
Direct Tension, TP3; Failure Strain, Minimum, 1.0% Test Temperature @ 1.0 mm/min, C	-12

E. Anti-stripping Agent:

1. Evaluate mixture of aggregate, asphalt, and additives proposed for use for moisture susceptibility and requirement for anti-stripping agents. To substantiate mix design, produce and test trial mixtures using proposed project materials and equipment prior to placement. Test for susceptibility to moisture and trial mixture may be waived by Engineer when similar designs using same material have previously proven satisfactory.
2. Liquid Anti-stripping Agent. Use anti-stripping agent with uniform liquid with no evidence of crystallization, settling, or separation of components. Submit sample of anti-stripping agent proposed for use and manufacturer's product data, including recommended dosage range, handling and storage, and application instructions.

F. Pavement markings for speed humps: Conform to requirements of Section 02767 - Thermoplastic Pavement Markings.

2.2 EQUIPMENT

- A. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuous mixtures meeting specifications. With exception of a drum mix plant, plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins, and dust collectors.
- B. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:
1. Cold aggregate bins and proportioning device
 2. Dryer
 3. Screens
 4. Aggregate weight box and batching scales
 5. Mixer
 6. Asphalt storage and heating devices
 7. Asphalt measuring devices
 8. Truck scales

- C. Bins: Separate aggregate into minimum of four bins to produce consistently uniform grading and asphalt content in completed mix. Provide one cold feed bin per stockpile.

2.3 MIXES

- A. Employ certified testing laboratory to prepare design mixes. Test in accordance with TxDOT Tex-126-E or Tex-204-F, Tex-206-F, Tex-208-F, Tex-530-C and Tex-531-C.

- B. Density, Stability and Air Void Requirements:

Percent Density		Percent	HVEEM Stability Percent
<u>Min</u>	<u>Max</u>	<u>Optimum</u>	Not Less Than
94.5	97.5	96	35

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted base course is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.2 PREPARATION

- A. Tack Coat: Conform to requirements of Section 02743 - Tack Coat. Where mixture will adhere to surface on which it is to be placed without use of tack coat, tack coat may be eliminated when approved by Engineer.
- B. Prepare subgrade in accordance with requirements of Section 02711 - Hot Mix Asphalt Base Course, Section 02712 - Cement Stabilized Base Course, or Section 02713 - Recycled Crushed Concrete Base Course.
- C. Prepare subgrade in advance of asphalt concrete paving operation.
- D. Perform pavement repair and resurfacing as indicated in Section 02951 - Pavement Repair and Resurfacing.
- E. Do not use cutback asphalt.
- F. Milling of pavement for speed humps: Mill pavement (concrete or asphalt) to depth of one inch and width between 18 and 24 inches around entire perimeter of

proposed hump, as shown in detail for speed hump design.

3.3 PLACEMENT

- A. Do not place asphalt pavement less than 2 inches thick when surface temperature taken in shade and away from artificial heat is below 50 F and falling. Asphalt may be placed when temperature is above 40 F and rising.
- B. Haul prepared and heated asphaltic concrete mixture to project in tight vehicles previously cleaned of foreign material. Mixture temperature shall be between 250 F and 325 F when laid.
- C. Spread material into place with approved mechanical spreading and finishing machine of screening or tamping type.
- D. Surface Course Material: Surface course 2 inches or less in thickness may be spread in one lift. Spread lifts in such a manner that, when compacted, finished course will be smooth, of uniform density, and will be to section, line and grade as shown. Place construction joints on surface courses to coincide with lane lines or as directed by Engineer.
- E. Joints: Pass roller over unprotected ends of freshly laid mixture only when mixture has cooled. When work is resumed, cut back laid material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.
- F. When new asphalt is laid against existing or old asphalt, saw cut existing or old asphalt to full depth to provide straight smooth joint.
- G. In smaller restricted areas where use of paver is impractical spread material by hand. Compact asphalt by mechanical means. Carefully place materials to avoid segregation of mix. Do not broadcast material. Remove lumps that do not break down readily.

3.4 COMPACTION

- A. Construct test strip to identify correct type, number, and sequence of rollers necessary to obtain specified in-place density or air-voids when directed by the Engineer. Prepare test strip at least 1,000 feet in length, comparable to placement and compaction conditions for Project.
- B. Begin rolling while pavement is still hot and as soon as it will bear roller without shoving, displacement or hair cracking. Keep wheels properly moistened with water to prevent adhesion of surface mixture. Do not use excessive water or petroleum by-products.

- C. Compact surface thoroughly and uniformly, first with power-driven, 3-wheel, or tandem rollers weighing a minimum of 8 tons. Obtain subsequent compression by starting at side and rolling longitudinally toward center of pavement, overlapping on successive trips by at least one-half width of rear wheels. Make alternate trips slightly different in length. Continue rolling until no further compression can be obtained and rolling marks are eliminated. Complete rolling before mat temperature drops below 185 F.
- D. Use tandem roller for final rolling. Double coverage with approved pneumatic roller on asphaltic concrete surface is acceptable after flat wheel and tandem rolling has been completed.
- E. Along walls, curbs, headers and similar structures, and in locations not accessible to rollers, compact mixture thoroughly with lightly oiled tamps.
- F. Compact binder course and surface course to a minimum density of 91 percent of maximum possible density of voidless mixture composed of same materials in like proportions.

3.5 TOLERANCES

- A. Furnish templates for checking surface in finished sections. Maximum deflection of templates, when supported at center, shall not exceed 1/8 inch.
- B. Completed surface, when tested with 10 foot straightedge laid parallel to center line of pavement, shall show no deviation in excess of 1/8 inch in 10 feet. Correct surface not meeting this requirement.
- C. Dimensions of speed humps shall conform to details for speed hump design and speed hump height tolerances.

3.6 QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. For in-place depth and density, take minimum of one core at random locations for each 1000 feet of single lane pavement. On a 2-lane pavement, take samples at random every 500 feet from alternating lanes. Take cores for parking lots every 500 square yards of base to determine in-place depth and density. If cul-de sac or streets are less than 500 feet, minimum of 2 cores (one per lane) will be procured. On small projects, take a minimum of two cores for each day's placement. For first days placement and prior to coring, minimum of 5 nuclear gauge readings will be performed at each core location to establish correlation between nuclear gauge (wet density reading) and core (bulk density). This process will continue for each day's placement until engineer determines that a

good bias has been established for that nuclear gauge.

- C. Determine in-place density in accordance with TxDOT Tex-207-F and Tex-227-F from cores or sections. Other methods of determining in-place density, which correlate satisfactorily with results obtained from roadway specimens, may be used when approved by Engineer. Average densities for each street placed in a single day to determine compliance.
- D. Contractor may request three additional cores in vicinity of cores indicating nonconforming in-place depths or density at no additional cost to Authority. In-place depth and density at these locations shall be average of four cores.
- E. Fill cores and density test sections with new compacted asphaltic concrete.
- F. Speed humps: Measure dimensions of completed speed hump, before applying pavement markings, at locations shown on Speed Hump Height Measurement Worksheet. Complete one worksheet for each speed hump, and send completed worksheets to the Authority.

3.7 NONCONFORMING PAVEMENT

- A. Recompect and retest nonconforming street sections not meeting surface test requirements or having unacceptable surface texture. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute. Retesting is at no cost to the Authority.
- B. Remove and replace areas of asphalt surface found deficient in thickness by more than 10 percent. Use new asphaltic surface of thickness shown on Drawings. Remove and replace areas of asphalt surface found deficient in average density.
- C. Replace speed humps which do not conform to requirements of details, or which are rejected by Engineer.

3.8 PROTECTION

- A. Do not open pavement to traffic until completion of rolling and temperature has cooled to set asphaltic concrete surface, or as shown on Drawings.
- B. Maintain asphalt pavement in good condition until completion of Work.
- C. Repair defects immediately by replacing asphalt pavement to full depth.

3.9 PAVEMENT MARKINGS FOR SPEED HUMPS

- A. Apply pavement markings to speed humps in conformance with dimensions

shown on detail for speed hump design.

END OF SECTION

Section 02742

PRIME COAT

PART 1 G E N E R A L

1.01 SECTION INCLUDES

Prime coat for asphalt concrete paving

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for prime coat under this Section. Include payment in unit price for material being primed.
2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for proposed prime coat.
- C. Submit report of recent calibration of distributor.

PART 2 P R O D U C T S

2.01 CUTBACK ASPHALT

- A. Provide moisture-free homogeneous material which will not foam when heated to 347 degrees F and which meets following requirements:
- B. Asphalt material for prime coat shall be MC-30 or MC-70 and shall meet following requirements:

PROPERTIES	TYPE - GRADE			
	MC-30		MC-70	
	MIN.	MAX.	MIN.	MAX.
Water, Percent	---	0.2	---	0.2
Flash Point, T.O.C., °F	100	---	100	---
Kinematic Viscosity at 140°F, cst	30	60	70	140

1. Distillate shall be as follows, expressed as percent by volume of total distillate to 680 degrees F:

TEMPERATURE	TYPE-GRADE			
	MC-30		MC-70	
	MIN.	MAX.	MIN.	MAX.
to 437°F	---	25	---	20
to 500°F	40	70	20	60
to 600°F	75	93	65	90
Residue from 680°F Distillation, Volume, Percent	50	---	55	---

2. Tests on Distillation Residue:

TEST	TYPE-GRADE			
	MC-30		MC-70	
	MIN.	MAX.	MIN.	MAX.
Penetration at 77°F, 100g, 5 sec.	120	250	120	250
Ductility at 77°F, 5 cm/min. cms	100*	---	100*	---
Solubility in Trichloroethylene, %	99	---	99	---
Spot Test	All Negative			

* If penetration of residue is more than 200 and ductility at 77 degrees F is less than 100 cm, material will be acceptable when its ductility at 60 degrees F is more than 100.

2.02 EMULSIFIED PETROLEUM RESIN

- A. EPR-1 Prime: Slow curing emulsion of petroleum resin and asphalt cement conforming to following requirements:

PROPERTIES	MIN.	MAX.
Fural Viscosity at 77°F, Sec	14	40
Residue by Evaporation, % by Weight	60	-
Sieve Test, %	-	0.1
Particle Charge Test	Positive	
Tests on Distillation Residue:		
Flash Point, COC (F)	400	-
Kinematic Viscosity @ 140 F (cst)	190	350

- B. For use, EPR-1 may be diluted with water up to maximum three parts water to one part EPR-1 in order to achieve desired concentration of residual resin/asphalt to facilitate application.

PART 3 E X E C U T I O N

3.01 EXAMINATION

- A. Verify base is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.02 PREPARATION

- A. Thoroughly clean base course surface of loose material by brooming prior to application of tack coat.
- B. Prepare sufficient base in advance of paving for efficient operations.

3.03 APPLICATION, BASIC

- A. Apply prime coat with approved type of self-propelled pressure distributor. Distribute prime coat evenly and smoothly under pressure necessary for proper distribution.
- B. Keep storage tanks, piping, retorts, booster tanks, and distributors used in handling asphalt materials clean and in good operating condition. Conduct operations so asphalt material does not become contaminated.
- C. If yield of asphaltic material appears to be in error, recalibrate distributor prior to continuing Work.
- D. Maintain surface until Work is accepted by the Authority.

3.04 APPLICATION, CUTBACK ASPHALT

- A. Do not use cutback asphalt during period of April 16 through September 15.
- B. Do not place prime coat when air temperature is below 60 degrees F and falling. Materials may be placed when air temperature taken in shade and away from artificial heat is above 50 degrees F and rising.
- C. Distribute at rate of 0.25 to 0.35 gallons per square yard.
- D. Equipment shall accurately determine temperature of asphaltic material in heating equipment and in distributor, for determining rate of application, and for obtaining uniformity at junction of two distributor loads. Maintain in accurate working order, including recording thermometer at storage heating unit.
- E. Base temperature of application on temperature-viscosity relationship that will permit application of asphalt with viscosity of 100 to 125 centistokes. Maintain asphalt within 15 degrees F of temperature required to meet viscosity. Selected temperature shall be within following range.

<u>Prime Coat Type</u>	<u>Minimum (°F)</u>	<u>Maximum (°F)</u>
MC-30	70	150
MC-70	125	175

F. Do not allow temperature of MC-30 to exceed 175 degrees F.

G. Do not allow temperature of MC-70 to exceed 200 degrees F.

3.05 APPLICATION, EMULSIFIED PETROLEUM RESIN

A. Do not place prime coat when air temperature is below 36 degrees F and falling.

B. Distribute at rate of 0.15 to 0.25 gallons per square yard.

3.06 PROTECTION

Prevent traffic or placement of subsequent courses over freshly applied prime coat until authorized by Engineer.

END OF SECTION

Section 02743

TACK COAT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tack coat for asphalt concrete paving.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for tack coat under this Section. Include payment in unit price for asphaltic pavements.
 - 2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 244 – Standard Test Methods for Emulsified Asphalts.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit product data for proposed tack coat.
- C. Submit report of recent calibration of distributor.

PART 2 PRODUCTS

2.01 EMULSION

- A. Provide homogeneous material which shows no separation of asphalt after mixing and meets viscosity requirements within 30 days after delivery.
- B. Emulsion material for tack coat.

1. Emulsified asphalt: SS-1 or SS-1h meeting following criteria:

PROPERTIES	SS-1		SS-1h	
	MIN.	MAX.	MIN.	MAX.
Furol Viscosity at 77°F, sec.	20	100	20	100
Residue by Distillation, %	60	--	60	--
Oil Portion of Distillate, %	--	1/2	--	1/2
Sieve Test, %	--	0.10	--	0.10
Miscibility (Standard Test)	Passing			
Cement Mixing, %	--	2.0	--	2.0
Storage Stability, 1 Day, %	--	1	--	1
Test on Residue:				
Penetration at 77°F, 100g, 5 sec.	120	160	70	100
Solubility in Trichloroethylene, %	97.5	--	97.5	--
Ductility at 77°F, 5 cm/min., cms	100	--	80	--

2. Polymer Modified Emulsion, SS-1P, for use where thin overlays (less than or equal 2 inches) are placed on collector or arterial streets and for speed humps, especially over existing Portland cement concrete pavement.

PROPERTIES	SS-1P	
	MIN.	MAX.
Furol Viscosity at 77°F, sec.	30	100
Residue by Distillation, %	60	--
Oil Portion of Distillate, %	--	1/2
Sieve Test, %	--	0.10
Miscibility (Standard Test)	Passing	
Cement Mixing, %	--	2.0
Storage Stability, 1 Day, %	--	1
Test on Residue:		
Penetration at 77°F, 100g, 5 sec.	100	140
Solubility in Trichloroethylene, %	97	--
Ductility at 77°F, 5 cm/min., cms	50	--
Viscosity at 140°F, poises	1300	--

3. For emulsions used for tack coats during period of April 16 through September 15, volatile organic compound solvents (VOC) shall not exceed 12 percent by weight when tested in accordance with ASTM D 244.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted base is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.02 PREPARATION

- A. Thoroughly clean base course or concrete surface of loose material by brooming prior to tack coat application.

3.03 APPLICATION

- A. Apply tack coat uniformly by use of approved distributor at rate not to exceed 0.05 gallons per square yard of surface depending on texture of underlying surface. Select an application rate that will provide appropriate asphalt residual.
- B. Paint contact surfaces of curbs, structures, and joints with thin uniform coat of tack coat.

3.04 PROTECTION

- A. Prevent traffic or placement of subsequent courses over freshly applied tack coat until authorized by Engineer.

END OF SECTION

Section 02751

CONCRETE PAVING

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Portland cement concrete paving.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for concrete paving is on square yard basis. Separate pay items are used for each different required thickness of pavement.
2. Payment for concrete paving, high early strength, is on square yard basis.
3. Payment for pavement repair or pavement replacement for utility projects is on a square yard basis and includes base materials in accordance with Section 02951 – Pavement Repair and Restoration.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
5. Refer to Paragraph 3.15, Unit Price Adjustment.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- B. ASTM A185 - Standard Specifications for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- C. ASTM A497 – Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
- D. ASTM A615 - Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.

- E. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- F. ASTM C 33 - Standard Specifications for Concrete Aggregates.
- G. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- H. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- I. ASTM C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- J. ASTM C 78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading).
- K. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- L. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- M. ASTM C 136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- N. ASTM C 138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- O. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- P. ASTM C 150 - Standard Specification for Portland Cement.
- Q. ASTM C 174 - Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.
- R. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- S. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- T. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- U. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or

Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.

- V. TxDOT Tex-203-F - Sand Equivalent Test.
- W. TxDOT Tex-406-A - Material Finer than 75 μ m (No. 200) Sieve In Mineral Aggregates (Decantation Test for Cement Aggregates).

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual flexural strength obtained from design mixes at required test ages.
- C. Submit for approval manufacturer's description and characteristics for mixing equipment, and for traveling form paver, when proposed for use.
- D. Submit manufacturer's certificates giving properties of reinforcing steel. Include certificate of compliance with ASTM A 82. Provide specimens for testing when required by Engineer.

1.5 HANDLING AND STORAGE

- A. Do not mix different classes of aggregate without written permission of Engineer.
- B. Class of aggregate being used may be changed before or during Work with written permission of Engineer. Comply new class with specifications.
- C. Reject segregated aggregate. Before using aggregate whose particles are separated by size, mix them uniformly to grading requirements.
- D. Reject aggregates mixed with dirt, weeds, or foreign matter.
- E. Do not dump or store aggregate in roadbed.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Portland Cement:

1. Sample and test cement to verify compliance with Standards of ASTM C 150, Type I or Type III.
 2. Bulk cement which meets referenced standards may be used when method of handling is approved by Engineer. When using bulk cement, provide satisfactory weighing devices.
 3. Fly ash which meets standards of ASTM C 618 may be used as mineral fill when method of handling is approved by Engineer.
- B. Water: Conform to requirements for water in ASTM C 94.
- C. Coarse Aggregate: Crushed stone, gravel, or combination thereof, which is clean, hard, and durable, conforms to requirements of ASTM C 33, and has abrasion loss not more than 45 percent by weight when subjected to Los Angeles Abrasion Test (ASTM C 131).
1. Maximum percentage by weight of deleterious substances shall not exceed following values:

<u>Item</u>	<u>Percent by Weight of Total Sample Maximum</u>
Clay lumps and friable particles	3.0
Material finer than 75-μm (No. 200) sieve:	3.0*
Concrete subject to abrasion	5.0*
All Other concrete	
Coal and lignite:	0.5
Where surface appearance of concrete is of importance	1.0
All other concrete	

* In case of manufactured sand, when material finer than 75-μm (No. 200) sieve consists of dust of fracture, essentially free from clay or shale, these limits may be increased to 5 and 7 percent, respectively.

2. Conform coarse aggregate (size 1 1/2 inch to No. 4 sieve) to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 1 3/4" sieve	0
Retained on 1 1/2" sieve	0 to 5
Retained on 3/4" sieve	30 to 65
Retained on 3/8" sieve	70 to 90
Retained on No. 4 sieve	95 to 100
Loss by Decantation Test *Method Tex-406-A	1.0 maximum

- * In case of aggregates made primarily from crushing of stone, when material finer than 200 sieve is dust of fracture essentially free from clay or shale as established by Part III of TxDOT Tex-406-A, percent may be increased to 1.5.

- D. Fine Aggregate: Sand, manufactured sand, or combination thereof, composed of clean, hard, durable, uncoated grains, free from loams or other injurious foreign matter. Conform fine aggregate for concrete to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 3/8" sieve	0
Retained on No. 4 sieve	0 to 5
Retained on No. 8 sieve	0 to 20
Retained on No. 16 sieve	15 to 50
Retained on No. 30 sieve	35 to 75
Retained on No. 50 sieve	65 to 90
Retained on No. 100 sieve	90 to 100
Retained on No. 200 sieve	97 to 100

1. When subjected to color test for organic impurities (ASTM C 40), fine aggregate shall not show color darker than standard color. Fine aggregate shall be subjected to Sand Equivalent Test (Tex-203-F). Sand equivalent value shall not be less than 80, unless higher value is shown on Drawings.

- E. Mineral Filler: Type "C" or Type "F" fly ash of acceptable quality and meeting requirements of ASTM C 618 may be used as mineral admixture in concrete mixture. When fly ash mineral filler is used, store and inspect in accordance with ASTM C 618. Do not use fly ash in amounts to exceed 25 percent by weight of cementitious material in mix design. Cement content may be reduced when strength requirements can be met. Note: When fly ash is used, term "cement" is defined as cement plus fly ash.
- F. Air Entraining Agent: Furnish air entraining agent conforming to requirements of ASTM C 260.
- G. Water Reducer: Water reducing admixture conforming to requirements of ASTM C 494 may be used when required to improve workability of concrete. Amount and type of admixture is subject to approval by Engineer.
- H. Reinforcing Steel:
 - 1. Provide new billet steel manufactured by open hearth process and conforming to ASTM A 615, Grade 60. Store steel to protect it from mechanical injury and rust. At time of placement, steel shall be free from dirt, scale, rust, paint, oil, or other injurious materials.
 - 2. Cold bend reinforcing steel to shapes shown. Once steel has been bent, it may not be rebent.
 - 3. Provide wire fabric conforming to ASTM A 82. Use fabric in which longitudinal and transverse wires have been electrically welded at points of intersection. Welds shall have sufficient strength not to be broken during handling or placing. Conform welding and fabrication of fabric sheets to ASTM A 185.

2.2 EQUIPMENT

- A. Conform Equipment to requirements of ASTM C94.

2.3 MIXING

- A. Flexural strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C78 (using simple beam with third-point loading). Compressive strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Determine and measure batch quantity of each ingredient, including water for batch designs and all concrete produced for Work. Mix shall conform to these specifications and other requirements indicated on Drawings.

- B. Mix design to produce concrete which will have flexural strength of 500 psi at 7 days and 600 psi at 28 days. Minimum compressive strength shall be 3000 pounds per square inches for 7 days and 4000 pounds per square inches at 28 days when tested in accordance with ASTM C39. Slump of concrete shall be at least 2 inches but no more than 5 inches, when tested in accordance with ASTM C143.
1. Concrete pavement, including curb, curb and gutter, and saw-tooth curb, shall contain at least 5 1/2 sacks (94 pounds per sack) of cement per cubic yard, with not more than 6.5 gallons of water, net, per sack of cement (water-cement ratio maximum 0.57). Determine cement content in accordance with ASTM C 138. Addition of mineral filler may be used to improve workability or plasticity of concrete to limits specified.
 2. Coarse dry aggregate shall not exceed 85 percent of loose volume of concrete.
 3. Add air-entraining admixture to ensure uniform distribution of agent throughout batch. Base air content of freshly mixed air-entrained concrete upon trial mixes with materials to be used in Work, adjusted to produce concrete of required plasticity and workability. Percentage of air entrainment in mix shall be 4 1/2 percent plus or minus 1 1/2 percent. Determine air content by testing in accordance with ASTM C 231.
 4. Use retardant when temperature exceeds 90 degrees F. Proportion as recommended by manufacturer. Use same brand as used for air-entraining agent. Add and batch material using same methods as used for air-entraining agent.
- C. Use high early strength concrete pavement to limits shown on Drawings. Design to meet following:
1. Concrete Mix: Flexural strength greater than or equal to 500 psi at 72 hours.
 2. Cement: Minimum of 7 sacks of cement per cubic yard of concrete.
 3. Water-Cement Ratio maximum of 0.45. Slump of concrete shall a maximum of 5 inches, when tested in accordance with ASTM C 143.
 4. Other requirements for proportioning, mixing, execution, testing, etc., shall be in accordance with this Section 02751 - Concrete Paving.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted base is ready to support imposed loads and meets compaction requirements.
- B. Verify lines and grades are correct.

3.2 PREPARATION

- A. Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete. After forms have been set to proper grade and alignment, use subgrade planer to shape subgrade to its final cross section. Check contour of subgrade with template.
- B. Remove subgrade that will not support loaded form. Replace and compact subgrade to required density.
- C. If the Contractor's work results in voids under adjacent lanes of pavement. Then unless otherwise directed by Authority, Contractor shall remove and replace the damaged pavement in accordance with specs, at no additional cost to the Authority.

3.3 EQUIPMENT

- A. Alternate equipment and methods, other than those required by this Section, may be used provided equal or better results will be obtained. Maintain equipment for preparing subgrade and for finishing and compacting concrete in good working order.
- B. Subgrade Planer and Template:
 - 1. Use subgrade planer with adjustable cutting blades to trim subgrade to exact section shown on Drawings. Select planer mounted on visible rollers which ride on forms. Planer frame must have sufficient weight so that it will remain on form, and have strength and rigidity that, under tests made by changing support from wheels to center, planer will not develop deflection of more than 1/8 inch. Tractors used to pull planer shall not produce ruts or indentations in subgrade. When slip form method of paving is used, operate subgrade planer on prepared track grade or have it controlled by electronic sensor system operated from string line to establish horizontal alignment and elevation of subbase.
 - 2. Provide template for checking contour of subgrade. Template shall be

long enough to rest upon side forms and have strength and rigidity that, when supported at center, maximum deflection shall not exceed 1/8 inch. Fit template with accurately adjustable rods projecting downward at 1 foot intervals. Adjust these rods to gauge cross sections of slab bottom when template is resting on side forms.

- C. Machine Finisher: Provide power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete. Machine shall have two screeds accurately adjusted to crown of pavement and with frame equipped to ride on forms. Use finishing machine with rubber tires when it operates on concrete pavement.
- D. Hand Finishing:
 - 1. Provide mechanical strike and tamping template 2 feet longer than width of pavement to be finished. Shape template to pavement section.
 - 2. Provide two bridges to ride on forms and span pavement for finishing expansion and dummy joints. Provide floats and necessary edging and finishing tools.
- E. Burlap Drag or transverse broom for Finishing Slab: Furnish four plies of 10 ounce burlap material fastened to bridge to form continuous strip of burlap full width of pavement. Maintain contact 3 foot width of burlap material with pavement surface. Keep burlap drags clean and free of encrusted mortar.
- F. Vibrators: Furnish mechanically-operated, synchronized vibrators mounted on tamping bar which rides on forms and hand-manipulated mechanical vibrators. Furnish vibrators with frequency of vibration to provide maximum consolidation of concrete without segregation.
- G. Traveling Form Paver: Approved traveling form paver may be used in lieu of construction methods employing forms, consolidating, finishing and floating equipment. Meet requirements of this specification for subgrade, pavement tolerances, pavement depth, alignments, consolidation, finishing and workmanship. When traveling form paver does not provide concrete paving that meets compaction, finish, and tolerance requirements of this Specification, immediately discontinue its use and use conventional methods.
 - 1. Equip traveling paver with longitudinal trans-angular finishing float adjustable to crown and grade. Use float long enough to extend across pavement to side forms or edge of slab.
 - 2. Ensure that continuous deposit of concrete can be made at paver to minimize starting and stopping. Use conventional means of paving locations inaccessible to traveling paver, or having horizontal or vertical

curvature that traveling paver cannot negotiate.

3. Where Drawings require tie bars for adjacent paving, securely tie and support bars to prevent displacement. Tie bars may be installed with approved mechanical bar inserter mounted on traveling-form paver. Replace pavement in which tie bars assume final position other than that shown on Drawings.

3.4 FORMS

- A. Side Forms: Use metal forms of approved shape and section. Preferred depth of form is equal to required edge thickness of pavement. Forms with depths greater or less than required edge thickness of pavement will be permitted, provided difference between form depth and edge thickness when not greater than 1 inch, and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form, or by grouting under form. Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. Forms shall be approved by Engineer. Length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200 foot radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than 8 inches for form 8 inches or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide straight edge on concrete. Top of each form section, when tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used. For curb returns at street intersections and driveways, wood forms of good grade and quality may be used.

- B. Form Setting:

1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. Do not remove forms for at least 8 hours after completion of finishing operations. Provide supply of forms that will be adequate for orderly and continuous placing of concrete. Set forms and check grade for at least 300 feet ahead of mixer or as approved by Engineer.
2. Adjacent slabs may be used instead of forms, provided that concrete is

well protected from possible damage by finishing equipment. Do not use adjacent slabs for forms until concrete has aged at least 7 days.

3.5 REINFORCING STEEL AND JOINT ASSEMBLIES

- A. Place reinforcing steel and joint assemblies and position securely as indicated on Drawings. Wire reinforcing bars securely together at intersections and splices. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Secure reinforcing steel to chairs.
- B. Position pavement joint assemblies at required locations and elevations, and rigidly secure in position. Install dowel bars in joint assemblies, each parallel to pavement surface and to center line of pavement, as shown.
- C. Cut header boards, joint filler, and other material used for forming joints to receive each dowel bar.
- D. Secure in required position to prevent displacement during placing and finishing of concrete.
- E. Drill dowels into existing pavement, secure with epoxy, and provide paving headers as required to provide rigid pavement sections.
- F. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

3.6 FIBROUS REINFORCING

- A. Do not use fibrous reinforcing to replace structural, load-bearing, or moment-reinforcing steel.

3.7 PLACEMENT

- A. Place concrete when air temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Do not place concrete when temperature is below 40 degrees F and falling.
- B. Place concrete within 90 minutes after initial water had been added. Remove and dispose of concrete not placed within this period.
- C. Concrete slump during placement shall be 1 to 5 inches, except when using traveling-form paver, slump shall be maximum of 2 inches.

- D. Deposit concrete continuously in successive batches. Distribute concrete in manner that will require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete. At placement interruption of more than 30 minutes, place transverse construction joint at stopping point. Remove and replace sections less than 10 feet long.
- E. Take special care in placing and spading concrete against forms and at longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement will be cause for rejection.

3.8 COMPACTION

- A. Consolidate concrete using mechanical vibrators as specified herein. Extend vibratory unit across pavement, not quite touching side forms. Space individual vibrators at close enough intervals to vibrate and consolidate entire width of pavement uniformly. Mount mechanical vibrators to avoid contact with forms, reinforcement, transverse or longitudinal joints.
- B. Furnish enough hand-manipulated mechanical vibrators for proper consolidation of concrete along forms, at joints and in areas not covered by mechanically controlled vibrators.

3.9 FINISHING

- A. Finish concrete pavement with power-driven transverse finishing machines or by hand finishing methods.
 - 1. Hand finish with mechanical strike and tamping template in same width as pavement to be finished. Shape template to pavement section shown on Drawings. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make minimum of two trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.
- B. On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.

- C. After completion of straightedge operation, make first pass of burlap drag or transverse broom as soon as construction operations permit and before water sheen has disappeared from surface. Follow with as many passes as required to produce desired texture depth. Permit no unnecessary delays between passes. Keep drag wet, clean and free from encrusted mortar during use.

3.10 JOINTS AND JOINT SEALING

- A. Conform to requirements of Section 02752 - Concrete Pavement Joints.

3.11 CONCRETE CURING

- A. Conform to requirements of Section 02753 - Concrete Pavement Curing.

3.12 TOLERANCES

- A. Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place 10 foot straightedge parallel to center of roadway to bridge depressions and touch high spots. Do not permit ordinates measured from face of straight edge to surface of pavement to exceed 1/16 inch per foot from nearest point of contact. Maximum ordinate with 10 foot straightedge shall not exceed 1/8 inch. Grind spots in excess of required tolerances to meet surface test requirements. Restore texture by grooving concrete to meet surface finishing specifications.

3.13 FIELD QUALITY CONTROL

- A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.
- B. Compressive Strength Test Specimens: Make four test specimens for compressive strength test in accordance with ASTM C 31 for each 150 cubic yards or less of pavement that is placed in one day. Test two specimens at 7 days or at number of hours as directed by the Engineer for high early strength concrete. Test remaining two specimens at 28 days. Test specimens in accordance with ASTM C 39. Minimum compressive strength shall be 3000 pounds per square inch for first two specimens and 3500 pounds per square inch at 28 days.
- C. When compressive test indicates failure, make yield test in accordance with ASTM C 138 for cement content per cubic yard of concrete. When cement content is found to be less than that specified per cubic yard, increase batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. Minimum of one 4 inch core will be taken at random locations per 375 feet

per 12 feet lane or 500 square yards of pavement to measure in-place depth. Measure depth in accordance with ASTM C 174. Each core may be tested for 28 day compressive strength according to methods of ASTM C 42. 28 day compressive strength of each core tested shall be a minimum of 3000 pounds per square inch.

- E. Request, at option, three additional cores in vicinity of cores indicating nonconforming in- place depths at no cost to Authority. In-place depth at these locations shall be average depth of four cores.
- F. Fill cores and density test sections with new concrete paving or non shrink grout.

3.14 NONCONFORMING PAVEMENT

- A. Remove and replace areas of pavement found deficient in thickness by more than 10 percent, or that fail compressive strength tests, with concrete of thickness shown on Drawings.
- B. When measurement of any core is less than specified thickness by more than 10 percent, actual thickness of pavement in this area will be determined by taking additional cores at 10 foot intervals parallel to centerline in each direction from deficient core until, in each direction, core is taken which is not deficient by more than 10 percent. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine length of pavement in unit that is to be removed and replaced.
Replace nonconforming pavement sections at no additional cost to Authority.

3.15 UNIT PRICE ADJUSTMENT

- A. Unit price adjustments shall be made for in-place depth determined by cores as follows:
 - 1. Adjusted Unit Price shall be ratio of average thickness as determined by cores to thickness bid upon, times unit price.
 - 2. Apply adjustment to lower limit of 90 percent and upper limit of 100 percent of unit price.
 - 3. Average depth below 90 percent but greater than 80 percent may be accepted by Engineer at adjusted Unit Price of:
 - a. $\text{Unit Price Bid} - [2 \times (1 - \text{ratio}) \times \text{Unit Price Bid}]$
 - b. Ratio equals average core thickness divided by thickness bid upon

- c. 0.9 ratio pays 80 percent of unit price and 0.8 ratio pays 60 percent of unit price.

- 4. Average depth below 80 percent will be rejected by Engineer.

3.16 PAVEMENT MARKINGS

- A. Restore pavement markings to match those existing in accordance with specifications and details and Engineer's requirements.

3.17 PROTECTION

- A. Barricade pavement section to prevent use until concrete has attained minimum design strength. Cure barricade pavement section for minimum 72 hours before use. Do not open pavement to traffic until concrete is at least 10 days old. Pavement may be open to traffic earlier provided Contractor pays for testing and additional specimen once 7 day specified strength is obtained. Pavement may be opened when high early strength concrete is used meeting specified 72 hour strength.
- B. High early strength concrete may be used to provide access at driveways, street intersections, esplanades and other locations approved by Engineer.
- C. On those sections of pavement to be opened to traffic, seal joints, clean pavement, and place earth against pavement edges before permitting use by traffic. Opening of pavement to traffic shall not relieve responsibility for Work.
- D. Maintain concrete paving in good condition until completion of Work.
- E. Repair defects by replacing concrete to full depth.

END OF SECTION

Section 02752

CONCRETE PAVEMENT JOINTS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Joints for concrete paving; concrete sidewalks, concrete driveways, curbs, and curb and gutters.
- B. Saw-cutting existing concrete or asphalt pavements for new joints.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for street pavement expansion joints, with or without load transfer, is on linear foot basis.
 - 2. Payment for horizontal dowels is on a unit price basis for each horizontal dowel.
 - 3. No separate payment will be made for formed or sawed street pavement contraction joints and longitudinal weakened plane joints. Include payment in unit price for Concrete Paving.
 - 4. No separate payment will be made for joints for Curb, Curb and Gutter, Saw-tooth Curb, Concrete Sidewalks, and Concrete Driveways. Include payment in unit price for Curb and Gutter, Concrete Sidewalks, and Concrete Driveways.
 - 5. Payment will be made for Preformed Expansion Joints on a linear foot basis only when field conditions require that sidewalk be moved adjacent to existing concrete structure (i.e., street, back of curb, etc.).
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- B. ASTM D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- C. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- D. ASTM D 3405/6690 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements.
- E. TxDOT Tex-525-C - Tests for Asphalt and Concrete Joint Sealers

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for joint sealing compound and proposed sealing equipment for approval.
- C. Submit samples of dowel cup, metal supports, and deformed metal strip for approval. Submit manufacturer's recommendation for placing sealant(s).

PART 2 P R O D U C T S

2.1 BOARD EXPANSION JOINT MATERIAL

- A. Filler board of selected stock. Use wood of density and type as follows:
 - 1. Clear, all-heart cypress weighing no more than 40 pounds per cubic foot, after being oven dried to constant weight.
 - 2. Clear, all-heart redwood weighing no more than 30 pounds per cubic foot, after being oven dried to constant weight.

2.2 PREFORMED EXPANSION JOINT MATERIAL

- A. Bituminous fiber and bituminous mastic composition material conforming to ASTM D 994 and ASTM D 1751.

2.3 JOINT SEALING COMPOUND

- A. Conform joint sealants to one of sealant classes described in this section.

- B. Conform hot-poured rubber-asphalt compound to ASTM D 3405/6690.
- C. Two-component Synthetic Polymer.
1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.
 2. Cure sufficiently at average temperature of 25 ± 1 C (77 ± 2 F) so as not to pick up under wheels of traffic in maximum three hours.
 3. Performance requirements, when tested in accordance with TxDOT Tex-525-C, shall meet above curing times and requirements as follows:

Cold-Extruded and Cold-Pourable (Self-Leveling) Specifications	
Property	Requirement
Penetration, 25 C (77 F) 150 g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29 C (-20 F), 3 cycles: *Dry Concrete Block *Steel blocks (Primed, if recommended by manufacturer) *Steel blocks shall be used when armor joints are specified	Pass Pass
Flow at 70 C (158 F)	None
Water content % by mass, maximum	5.0
Resilience: * Original sample, % min. (cured) * Oven-aged at 70 C (158 F), % min.	50 50
Cold-extruded material only - Cold Flow (10 minutes)	None

After bond and extension test, there shall be no evidence of cracking, separation or other opening that is over 3 millimeters (1/8 inch) deep in sealer or between sealer and test blocks.

4. Provide cold-extruded type for vertical or sloping joints.
 5. Provide self-leveling type for horizontal joints.
- D. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a

backer rod shall be required which is compatible with the sealant; no reaction shall occur between rod and sealant.

When tested in accordance with TxDOT Tex-525-C, self-leveling sealant shall meet following requirements:

Self-Leveling, Low Modulus Silicone or Polyurethane Sealant	
Property	Requirements
Tack Free Time, 25 ± 1 C (77 ± 2 F), minutes	120 maximum
Nonvolatile content, % by mass	93 minimum
Tensile Strength and 24 Hour Extension Test: * Initial, 10-day cure, 25 ± 1 C (77 ± 2 F), kPa (psi) * After Water Immersion, kPa (psi) * After Heat Aging, kPa (psi) * After Cycling, -29 C (-20 F), 50%, 3 cycles, kPa (psi) * 24 Hour Extension	* 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * Pass (All Specimens) After 24 hours, there shall be no evidence of cracking, separation or other opening that is over 3 mm (1/8 in.) deep at any point in the sealer or between the sealer and test blocks.

2.4 LOAD TRANSMISSION DEVICES

- A. Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Drawings, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.
- B. Deformed steel tie bars conforming to ASTM A 615, Grade 60.

2.5 SUPPORTS FOR REINFORCING STEEL AND JOINT ASSEMBLY

- A. Employ supports of approved shape and size that will secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by Engineer.

PART 3 EXECUTION

3.1 PLACEMENT

- A. When new Work is adjacent to existing concrete pavement and existing joint is an expansion joint, then place joints at same location as existing joints in adjacent pavement. Dowels at existing expansion joints shall be saw cut to eliminate possible damage to adjacent pavement that is scheduled to remain. The cost for this saw cut is incidental to the pavement removal and disposal pay item(s).
- B. When new Work is adjacent to existing concrete and existing joint is a construction joint (e.g. deformed metal strip joints, tooled joints, partially saw cut joints with sealant), then unless otherwise directed by the Engineer, provide full-depth saw cut 2-inch maximum away from pavement construction joints. Saw cut distance from joint shall be minimum necessary for a clean straight edge, and if the joint is at the crown the saw cut shall be as close to the crown as possible. Saw cut shall provide straight, smooth joint surface without chipping, spalling or cracks.
- C. If limit of removal of existing concrete or asphalt pavement does not fall on existing joint, saw cut existing pavement minimum of 2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

3.2 CONSTRUCTION JOINTS

- A. Place transverse construction joint wherever concrete placement must be stopped for more than 30 minutes. Place longitudinal construction joints at interior edges of pavement lanes using No. 6 deformed tie bars, 30 inches long and spaced 18 inches on centers.

3.3 EXPANSION JOINTS

- A. Place 3/4 inch expansion joints at radius points of curb returns for cross street intersections, or as located in adjacent pavement but no further than 80 feet apart. Use no boards shorter than 6 feet. When pavement is 24 feet or narrower, use not more than 2 lengths of board. Secure pieces to form straight joint. Shape board filler accurately to cross section of concrete slab. Use load transmission devices of type and size shown on Drawings unless otherwise specified or shown as "No Load Transfer Device." Seal with joint sealing compound.

3.4 CONTRACTION JOINTS

- A. Place contraction joints at same locations as in adjacent pavement or at spaces indicated on Drawings. Place smoothed, painted and oiled dowels accurately and normal to joint. Seal groove with joint sealing compound.

3.5 LONGITUDINAL WEAKENED PLANE JOINTS

- A. Place longitudinal weakened plane joints at spaces indicated on Drawings. If

more than 15 feet in width is poured, longitudinal joint must be saw cut. Seal groove with joint sealing compound.

3.6 SAWED JOINTS

- A. Use sawed joints as alternate to contraction and weakened plane joints. Use circular cutter capable of cutting straight line groove minimum of 1/4 inch wide. Maintain depth of one quarter of pavement thickness. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, continue until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.

- B. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Maintain ample supply of saw blades at

work site during sawing operations. Maintain sawing equipment on job during concrete placement.

3.7 JOINTS FOR CURB, CURB AND GUTTER

- A. Place 3/4 inch preformed expansion joints through curb and gutters at locations of expansion and contraction joints in pavement, at end of radius returns at street intersections and driveways, and at curb inlets. Maximum spacing shall be 120-foot centers.

3.8 JOINTS FOR CONCRETE SIDEWALKS

- A. Provide 3/4 inch expansion joints conforming to ASTM A 1751 along and across sidewalk at back of curbs, at intersections with driveways, steps, and walls; and across walk at intervals not to exceed 36 feet. Provide expansion joint material conforming to ASTM D 994 for small radius curves and around fire hydrants and utility poles. Extend expansion joint material full depth of slab.

3.9 JOINTS FOR CONCRETE DRIVEWAYS

- A. Provide 3/4-inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab.

3.10 JOINT SEALING

- A. Seal joints only when surface and joints are dry, ambient temperature is above 50

degrees F and less than 85 degrees F and weather is not foggy or rainy.

- B. Use joint sealing equipment in like new working condition throughout joint sealing operation, and be approved by Engineer. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.
- C. Clean joints of loose scale, dirt, dust and curing compound. The term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.
- D. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch above level of adjacent surface or at elevation as directed.

3.11 PROTECTION

- A. Maintain joints in good condition until completion of Work.
- B. Replace damaged joints material with new material as required by this Section.

END OF SECTION

Section 02753

CONCRETE PAVEMENT CURING

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Curing of Portland cement concrete paving.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for concrete curing under this Section. Include payment in unit price for 02751 - Concrete Paving, 02775 - Concrete Sidewalks, 02754 - Concrete Driveways, 02771 - Curbs, Curb and Gutters, and Headers.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 156 - Standard Test Method for Water Retention by Concrete Curing Materials.
- B. ASTM C 171 - Standard Specifications for Sheet Materials for Curing Concrete.
- C. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.
- D. ACI 308R – Guide to Curing Concrete

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's product data for cover materials and liquid membrane-forming compounds.

PART 2 P R O D U C T S

2.1 COVER MATERIALS FOR CURING

- A. Conform curing materials to one of the following:
 - 1. Polyethylene Film: Opaque pigmented white film conforming to requirements of ASTM C 171.
 - 2. Waterproofed Paper: Paper conforming to requirements of ASTM C 171.
 - 3. Cotton Mats: Single layer of cotton filler completely enclosed in cover of cotton cloth. Mats shall contain not less than 3/4 of a pound of uniformly distributed cotton filler per square yard of mat. Cotton cloth used for covering materials shall weigh not less than 6 ounces per square yard. Stitch mats so that mat will contact surface of pavement at all points when saturated with water.

2.2 LIQUID MEMBRANE-FORMING COMPOUNDS

- A. Conform liquid membrane-forming compounds to ASTM C 309. Membrane shall restrict loss of water to not more than 0.55 kg/m^2 in 72 hours using test method ASTM C 156.

PART 3 E X E C U T I O N

3.1 CURING REQUIREMENT

- A. Cure concrete pavement by protecting against loss of moisture for period of not less than 72 hours immediately upon completion of finishing operations. Do not use membrane curing for concrete pavement to be overlaid by asphalt concrete.
- B. Failure to provide sufficient cover material shall be cause for immediate suspension of concreting operations.

3.2 POLYETHYLENE FILM CURING

- A. Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with polyethylene film so film will remain in direct contact with surface during specified curing period.
- B. Cover entire surface and both edges of pavement slab. Overlap joints in film sheets minimum of 12 inches. Immediately repair tears or holes occurring during curing period by placing acceptable moisture-proof patches or replacing.

3.3 WATERPROOFED PAPER CURING

- A. Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with waterproofed paper so paper will remain in direct contact with surface during specified curing period.
- B. Prepare waterproofed paper to form blankets of sufficient width to cover entire surface and both edges of pavement slab, and not be more than 60 feet in length. Overlap joints in blankets caused by joining paper sheets not less than 5 inches and securely seal with asphalt cement having melting point of approximately 180 degrees F. Place blankets to secure overlap of at least 12 inches. Immediately repair tears or holes appearing in paper during curing period by cementing patches over defects.

3.4 COTTON MAT CURING

- A. Immediately after finishing surface, and after concrete has taken its initial set, completely cover surface with cotton mats, thoroughly saturated before application, maintaining contact with surface of pavement equally at all points.
- B. Keep mats on pavement for specified curing period. Keep mats saturated so that, when lightly compressed, water will drip freely from them. Keep banked earth or cotton mat covering edges saturated.

3.5 LIQUID MEMBRANE-FORMING COMPOUNDS

- A. Immediately after free surface moisture, and after concrete has dispersed, apply liquid membrane-forming compound in accordance with manufacturer's instructions.
- B. Moisten concrete by water fogging prior to application of membrane when surface has become dry.
- C. Seal concrete surface with single coat at rate of coverage recommended by manufacturer and directed by Engineer, but not less than one gallon per 200 square feet of surface area.

3.6 TESTING MEMBRANE

- A. Treated areas will be visually inspected for areas of lighter color of dry concrete as compared to dump concrete. Test suspected areas by placing few drops of water on surface. Membrane passes test when water stands in rounded beads or small pools which can be blown along surface of concrete without wetting surface.

- B. Reapply membrane compound immediately at no cost to Authority when membrane fails above test.

END OF SECTION

Section 02754

CONCRETE DRIVEWAYS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Portland cement concrete driveways.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for concrete driveways is on square foot basis, including excavation.
 - 2. No payment will be made for work in areas where driveway has been removed or replaced for Contractor's convenience.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for reinforcing steel of Section 02751 - Concrete Paving.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02752 - Concrete Pavement Joints.

- E. Subgrade Materials: Conform to subgrade material requirements of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, or Section 02338 - Portland Cement Stabilized Subgrade.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, and Section 02338 - Portland Cement Stabilized Subgrade.

3.2 PLACEMENT

- A. Place and finish concrete in accordance with applicable portions of Section 02751 - Concrete Paving.

3.3 JOINTS

- A. Install joints in concrete driveway in accordance with Section 02752 - Concrete Pavement Joints.

3.4 CONCRETE CURING

- A. Cure concrete driveway in accordance with Section 02753 - Concrete Pavement Curing.

3.5 PROTECTION

- A. Conform to applicable requirements of Section 02753 - Concrete Pavement Curing.

END OF SECTION

Section 02767

THERMOPLASTIC PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This item includes the application of thermoplastic pavement markings, in conformance with the minimum optical and physical properties required for a thermoplastic road marking compound described herein, in a molten state, onto a pavement surface.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. Payment for thermoplastic pavement markings is on a linear foot basis.
- 2. Payment for words and symbols is for each word or symbol.
- 3. Payment for green colored pavement markings is on a square foot basis.
- 4. Payment for railroad crossing markings, to include stop line and two transverse lines, is for each crossing marked. For multi-lane approaches to railroad crossings, the solid 8-inch lines will be measured in linear feet, complete in place.
- 5. Unit price bid for each item shall be full compensation for materials, application of pavement markings, equipment, labor, tools, and incidentals necessary to complete Work in accordance with the plans and specifications.

- B. Stipulated Price (Lump Sum). When Contract is Stipulated Price Contract, payment for work in the Section is included in total Stipulated Price.

1.3 MATERIAL

- A. All materials shall conform to the requirements of TxDOT DMS-8220 "Hot Applied Thermoplastic." Thermoplastic materials shall be stored in a dry environment to minimize the amount of moisture retained during storage.
- B. Materials used for green colored pavement (bicycle green) shall be manufactured with appropriate pigment to ensure that the resulting colors

comply with the Light Green color as specified in the FHWA memorandum dated 4/15/2011: "Interim Approval for Optimal Use of Green Colored Pavement for Bike Lanes (IA-14)". Green colored pavement to be defined as transverse markings.

1.4 EQUIPMENT

- A. Provide the necessary equipment to conduct the work specified herein. All equipment shall be maintained in good working order such that neat and clean thermoplastic markings are applied at the proper thicknesses and glass beads are placed at the correct rate. Equipment that is deemed deficient by the Engineer shall be replaced immediately.

PART 2 PRODUCTS

2.01 CONSTRUCTION

The appearance of the finished markings shall have a uniform surface, crisp edges with a minimum over-spray, clean cut-off, meet straightness requirements and conform to the design drawings and/or DPOR instructions.

The contractor shall provide the Engineer with certification from the marking manufacturer that contractor has been adequately trained and certified to apply the manufacturer's material. This certification shall be considered current if the certification date provided by the manufacturer is within two years of the date of marking application.

All striping and pavement markings shall be placed in accordance with the requirements of this specification, the detailed plans, and the current edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). The Contractor shall provide all other engineering services necessary for pre-marking of all proposed stripe within the limits of the designated work.

Unless authorized otherwise in writing by the Engineer, striping shall be accomplished during daylight hours. Approved lighting arrangements will be required for night time operations when allowed. The Contractor may be required to place markings over existing markings, as determined by the Engineer. The Contractor shall adjust the operation of the thermoplastic screed shoe to match the previous lengths of stripes and skips, when necessary.

Failure of the striping material to adhere to the pavement surface during the life of the contract shall be prima facie evidence that the materials, even though complying with these specifications, or the application thereof, was inconsistent with the intent of the requirements for the work under the latest

specifications and shall be cause for ordering corrective action or replacement of the marking without additional cost to the Authority.

Unless otherwise approved by the Engineer, permanent pavement markings on newly constructed pavements surfaced with asphaltic concrete or bituminous seals shall not be applied for a minimum of 14 days or a maximum 35 days. Temporary pavement marking shall be provided during the 14 to 35-day period.

A. Surface Preparation.

1. Moisture. All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two square feet of a clear plastic or tar paper shall be laid on the road surface and held in place for 15 to 20 minutes. The underside of the plastic or tar paper shall then be inspected for a buildup of condensed moisture from the road surface. Pavement is considered dry if there is no condensation on the underside of the plastic or tarpaper. In the event of moisture, this test shall be repeated until there is no moisture on the underside of the plastic or tar paper.
2. Cleaning. All surfaces shall be clean and dry, as defined in Section 535.4.A.1, before thermoplastic can be applied. Loose dirt and debris shall be removed by thoroughly blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines, the paint line shall be swept with a mechanical sweeper or wire brush to remove poorly adhered paint and dirt that would interfere with the proper bonding of the thermoplastic. Additional cleaning through the use of compressed air may be required to remove embedded dirt and debris after sweeping. Latence and curing compound shall be removed from all new Portland cement concrete surfaces in accordance with Section 02762, "Blast Cleaning of Pavement."
3. Layout. The pavement markings shall be placed in proper alignment with guidelines established on the roadway. Deviation from the alignment established shall not exceed 2 inches and, in addition, the deviation in alignment of the marking being placed shall not exceed 1 inch per 200 feet of roadway nor shall any deviation be abrupt.

No striping material shall be applied over a guide cord; only longitudinal joints, existing stripes, primer, or other approved type guides will be permitted. In the absence of a longitudinal joint or existing stripe, the Contractor shall mark the points necessary for the placing of the proposed stripe. Edge striping shall be adjusted as necessary so that the edge stripe will be parallel to the centerline and

shall not be placed off the edge of the pavement.

Longitudinal markings shall be offset at least 2-inches from construction joints of Portland cement concrete surfaces and joints and shoulder breaks of asphalt surfaces.

4. **Primer Sealer.** Primer sealer shall be used on all Portland cement concrete surfaces. A primer sealer shall be used on asphalt surfaces that are over two years old and/or on asphalt surfaces that are worn or oxidized to a condition where 50 percent or more of the wearing surface is exposed aggregate. Existing pavement markings may act as the primer sealer if, after cleaning, more than 70 percent of the existing pavement marking is still properly bonded to the asphalt surface.
5. **Primer Sealer Application.** When required as described, the primer-sealer shall be applied to the road surface in a continuous film at a minimum thickness of 3 to 5 mils. Before the Thermoplastic is applied, the primer-sealer shall be allowed to dry to a tacky state. The thermoplastic shall be applied within 4 hours after the primer application.

B. Temperature Requirements.

1. **Ambient Conditions.** The ambient air and road surface shall be 55 degrees F and rising before application of thermoplastic can begin.
2. **Material Requirements.** Unless otherwise specified by the material manufacturer, the thermoplastic compound shall be heated from 400 degrees F to 450 degrees F and shall be a minimum of 400 degrees F as it makes contact with road surface during application. An infrared temperature gun shall be used to determine the temperature of the thermoplastic as it is being applied to the road surface.

C. Drop-on Glass Sphere Application.

1. **Application Rate.** Retro-reflective glass spheres shall be applied at the rate of 10 pounds per 100 square feet of applied markings. This application rate shall be determined by confirming the following consumption rates:
 - a. 200 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.090 inch film thickness.
 - b. 150 pounds of drop on glass spheres per ton of applied

thermoplastic when the thermoplastic is being applied at 0.125 inch thickness.

2. Application Method. Retro-reflective glass spheres shall be applied by a mechanical dispenser properly calibrated and adjusted to provide proper application rates and uniform distribution of the spheres across the cross section of the entire width of the line. To enable the spheres to embed themselves into the hot thermoplastic, the sphere dispenser shall be positioned immediately behind the thermoplastic application device. This insures that the spheres are applied to the thermoplastic material while it is still in the molten state.

D. Application Thickness.

1. Longitudinal and Transverse Markings. On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in traffic areas with $\leq 1,000$ vehicles per day per lane shall have a minimum film thickness of 0.090 inch at the edges and a maximum of 0.145 inch at the center. A minimum average film thickness of 0.090 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.060 inch for re-application over existing strip line.
2. High Wear Longitudinal and Transverse Marking. On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in high traffic areas ($>1,000$ vehicles per day per lane) shall have a minimum film thickness of 0.125 inch at the edges and a maximum of 0.188 inch at the center. A minimum average film thickness of 0.125 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.090 inch for re-application over existing strip line.

E. Packaging.

1. Containers. The thermoplastic material shall be delivered in 50 pound containers or bags of sufficient strength to permit normal handling during shipment and handling on the job without loss of material.
2. Labeling. Each container shall be clearly marked to indicate the color of the material, the process batch number and/or manufacturer's

formulation number, the manufacturer's name and address and the date of manufacture.

F. Acceptance.

1. Sampling Procedure. Random samples may be taken at the job site at the discretion of the Engineer for quality assurance. The Authority reserves the right to conduct the tests deemed necessary to identify component materials and verify results of specific tests indicated in conjunction with the specification requirements.

The sample(s) shall be labeled as to the shipment number, lot number, date, quantity, and any other pertinent information. At least three randomly selected bags shall be obtained from each lot. A 10 pound) sample from the three bags shall be submitted for testing and acceptance. The lot size shall be approximately 44,000 pounds unless the total order is less than this amount.

2. Manufacturer's Responsibility.

- a. Sampling and Testing. The manufacturer shall submit test results from an approved independent laboratory. All material samples shall be obtained 20 days in advance of the pavement marking operations. The cost of testing shall be included in the price of thermoplastic material. The approved independent laboratory's test results shall be submitted to the Engineer in the form of a certified testreport.
- b. Bill of Lading. The manufacturer shall furnish the Material and Tests Laboratory with copies of Bills of Lading for all materials inspected. Bill of lading shall indicate the consignee and the destination, date of shipment, lot numbers, quantity, type of material, and location of source.
- c. Material Acceptance. Final acceptance of a particular lot of thermoplastic will be based on the following.
 - (1) Compliance with the specification for material composition requirements verified by approved independent laboratory with tests results.
 - (2) Compliance with the specification for the physical properties required and verified by an approved independent laboratory with test results.
 - (3) Manufacturer's test results for each lot thermoplastic have

been received.

(4) Identification requirements are satisfactory.

3. Contractor's Responsibility.

- a. Notification. The contractor shall notify the Resident Project Representative 72 hours prior to the placement of the thermoplastic markings to enable the RPR to be present during the application operation. At the time of notification, the Contractor shall indicate the manufacturer and the lot numbers of the thermoplastic that will be used.

A check should be made by the contractor to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

- b. Warranty or Guarantee. If the normal trade practice for manufacturers is to furnish warranties or guarantees for the materials and equipment specified herein, the Contractor shall turn the guarantees and warranties over to the Engineer for potential dealing with the manufacturers. The extent of such warranties or guarantees will not be a factor in selecting the successful bidder.

END OF SECTION

Section 02771

CURB, CURB AND GUTTER, AND HEADERS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Reinforced concrete curb, reinforced monolithic concrete curb and gutter, and mountable curb.
- B. Paving headers and railroad headers poured monolithically with concrete base or pavement.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for curbs, curbs and gutter, and esplanade curbs is on linear foot basis measured along face of curb.
 - 2. Payment for 3 foot concrete valley gutter is on a linear foot basis.
 - 3. Payment for mountable concrete curbs is on a square foot basis.
 - 4. Payment for concrete paving headers and concrete railroad headers is on a linear foot basis.
 - 5. Payment for headers is on linear foot basis measured between lips of gutters adjacent to concrete base and measured between backs of curbs adjacent to concrete pavement.
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit details of proposed form work for approval.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for welded wire fabric of Section 02751 - Concrete Paving.
- C. Grout: Nonmetallic, nonshrink grout containing no chloride producing agents conforming to following requirements.
 - 1. Compressive strength
 - a. at 7 days: 3500 psi
 - b. at 28 days: 8000 psi
 - 2. Initial set time: 45 minutes
 - 3. Final set time: 1.5 hours
- D. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- E. Expansion Joint Filler: Conform to material requirements for expansion joint filler of Section 02752 - Concrete Pavement Joints.
- F. Mortar: Mortar finish composed of one part Portland cement and 1 1/2 parts of fine aggregate. Use only when approved by Engineer.

PART 3 E X E C U T I O N

3.1 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of sections on excavation and fill, embankment, and subgrade and roadbed.

3.2 PLACEMENT

- A. Guideline: Set to follow top line of curb. Attach indicator to provide constant comparison between top of curb and guideline. Ensure flow lines for monolithic curb and gutters conform to slopes indicated on Drawings.

- B. Forms: Brace to maintain position during pour. Use metal templates cut to section shown on Drawings.
- C. Reinforcement: Secure in position so that steel will remain in place throughout placement. Reinforcing steel shall remain at approximate center of base or pavement as indicated on Drawings.
- D. Joints: Place in accordance with Section 02752 - Concrete Pavement Joints. Place dummy groove joints at to match concrete pavement joints at right angles to curb lines. Cut dummy grooves 1/4 inch deep using approved edging tool.
- E. Place concrete in forms to required depth. Consolidate thoroughly. Do not permit rock pockets in form. Entirely cover top surfaces with mortar.

3.3 MANUAL FINISHING

- A. After concrete is in place, remove front curb forms. Form exposed portions of curb, and of curb and gutter, using mule which conforms to curb shape, as shown on Drawings.
- B. Thin coat of mortar may be worked into exposed face of curb using mule and two-handled wooden darby at least 3 feet long.
- C. Before applying final finish move 10 foot straightedge across gutter and up curb to back form of curb. Repeat until curb and gutter are true to grade and section. Lap straightedge every 5 feet.
- D. Steel trowel finish surfaces to smooth, even finish. Make face of finished curb true and straight.
- E. Edge outer edge of gutter with 1/4 inch edger. Finish edges with tool having 1/4 inch radius.
- F. Finish visible surfaces and edges of finished curb and gutter free from blemishes, form marks and tool marks. Finished curb or curb and gutter shall have uniform color, shape and appearance.

3.4 MECHANICAL FINISHING

- A. Mechanical curb forming and finishing machines may be used instead of, or in conjunction with, previously described methods, when approved by Engineer. Use of mechanical methods shall provide specified curb design and finish.

3.5 CURING

- A. Immediately after finishing operations, cure exposed surfaces of curbs and gutters in accordance with Section 02753 - Concrete Pavement Curing.
- 3.6 TOLERANCES
- A. Top surfaces of curb and gutter shall have uniform width and shall be free from humps, sags or other irregularities. Surfaces of curb top, curb face and gutter shall not vary more than 1/8 inch from edge of straightedge laid along them, except at grade changes.
- 3.7 PROTECTION
- A. Maintain curbs and gutters in good condition until completion of Work.
 - B. Replace damaged curbs and gutters to comply with this Section.

END OF SECTION

Section 02775

CONCRETE SIDEWALKS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Reinforced concrete sidewalks.
- B. Wheelchair ramps.
- C. Reinforced slope paving.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for concrete sidewalks is on square foot basis.
 - 2. No payment will be made for work outside these limits or in areas where driveway has been removed or replaced for Contractor's convenience.
 - 3. Payment for wheelchair ramps of each type specified is on square foot basis. Removal and replacement of existing sidewalk, curb or curb and gutter and saw-cutting is paid by unit cost for each item. Sodding will be paid one foot on each side of sidewalk unless otherwise noted. Staining of wheelchair ramps is included in cost of ramp.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in Field.
- B. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- C. ASTM C 42 - Test Method for Obtaining and Testing Drilled Cores and Sawed

Beams of Concrete.

- D. ASTM C 138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- E. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- F. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
- G. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- H. Texas Accessibility Standards of Architectural Barriers Act, Article 9102, Texas Civil Statutes.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certified testing results and certificates of compliance.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements of Section 02751 - Concrete Paving for reinforcing steel. Use No. 3 reinforcing bars.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02752 - Concrete Pavement Joints.
- E. Forms: Use straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. The use of 2 inch by 4 inch lumber as forms will not be allowed.
- F. Sand Bed: Conform to material requirements for bank run sand of Section 02320 - Utility Backfill Materials.
- G. Sodding: Conform to material requirements for sodding of Section 02922 -

Sodding.

- H. Coloring for wheelchair ramps: Conform to material requirements for colored concrete of Section 02761 - Colored Concrete for Medians and Sidewalks. Color shall be Brick Red or as shown on the drawings.

PART 3 EXECUTION

3.1 REPLACEMENT

- A. Replace sidewalks and slope paving which are removed or damaged during construction with thickness and width equivalent to one removed or damaged, unless otherwise shown on Drawings. Finish surface (exposed aggregate, brick pavers, etc.) to match existing sidewalk.
- B. Provide replaced and new sidewalks with wheelchair ramps when sidewalk intersects curb at street or driveway.

3.2 PREPARATION

- A. Identify and protect utilities which are to remain.
- B. Protect living trees, other plant growth, and features designated to remain.
- C. Conduct clearing and grubbing operations in accordance with Section 02233 - Clearing and Grubbing.
- D. Excavate subgrade 6 inches beyond outside lines of sidewalk. Shape to line, grade and cross section. For soils with plasticity index above 40 percent, stabilize soil with lime in accordance with Section 02336 – Lime-Stabilized Subgrade. Compact subgrade to minimum of 90 percent maximum dry density at optimum to 3 percent above optimum moisture content, as determined by ASTM D 698.
- E. Immediately after subgrade is prepared, cover with compacted sand bed to depth as shown on Drawings. Lay concrete when sand is moist but not saturated.

3.3 PLACEMENT

- A. Setting Forms: Straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. Use of 2 by 4's as forms will not be allowed. Securely stake forms to line and grade. Maintain position during concrete placement.
- B. Reinforcement:

1. Install reinforcing bars.
 2. Install reinforcing steel as shown on the drawings. Lay longitudinal bars in walk continuously, except through expansion joints.
 3. Use sufficient number of chairs to support reinforcement in manner to maintain reinforcement in center of slab vertically during placement.
 4. Drill dowels into existing paving, sidewalk and driveways, secure with epoxy, and provide headers as required.
 5. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.
- C. Expansion Joints: Install expansion joints with load transfer units in accordance with Section 02752 - Concrete Pavement Joints.
- E. Place concrete in forms to specified depth and tamp thoroughly with "jitterbug" tamp, or other acceptable method. Bring mortar to surface.
- F. Strike off to smooth finish with wood strike board. Finish smoothly with wood hand float. Brush across sidewalk lightly with fine-haired brush.
- G. Apply coating to wheelchair ramp with contrasting color in accordance with Section 02761 - Colored Concrete for Medians and Sidewalks.
- H. Unless otherwise indicated on Drawings, mark off sidewalk joints 1/8 inch deep, at spacing equal to width of walk. Use joint tool equal in width to edging tool.
- I. Finish edges with tool having 1/4 inch radius.
- J. After concrete has set sufficiently, refill space along sides of sidewalk to one-inch from top of walk with suitable material. Tamp until firm and solid, place sod as applicable. Dispose of excess material in accordance with Section 01576 - Waste Material Disposal. Repair driveways and parking lots damaged by sidewalk excavation in accordance with Section 02951 - Pavement Repair and Resurfacing.
- 3.4 CURING
- A. Conform to requirements of Section 02753 - Concrete Pavement Curing.

3.5 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Compressive Strength Test Specimens: Four test specimens for compressive strength test will be made in accordance with ASTM C 31 for each 30 cubic yards or less of sidewalk that is placed in one day. Two specimens will be tested at 7 days. Remaining two specimens will be tested at 28 days. Specimens will be tested in accordance with ASTM C 39. Minimum compressive strength: 3000 psi at 7 days and 3500 psi at 28 days.
- C. Yield test for cement content per cubic yard of concrete will be made in accordance with ASTM C 138. When cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. If the Contractor places concrete without notifying the laboratory, the Authority will have the concrete tested by means of core test as specified in ASTM C 42. When concrete does not meet specification, cost of test will be deducted from payment.
- E. Sampling of fresh concrete shall be in accordance with ASTM C 172.
- F. Take slump tests when cylinders are made and when concrete slump appears excessive.
- G. Concrete shall be acceptable when average of two 28 day compression tests is equal to or greater than minimum 28 day strength specified.
- H. If either of two tests on field samples is less than average of two tests by more than 10 percent, that entire test shall be considered erratic and not indicative of concrete strength. Core samples will be required of in-place concrete in question.
- I. If 28 day laboratory test indicates that concrete of low strength has been placed, test concrete in question by taking cores as directed by Engineer. Take and test at least three representative cores as specified in ASTM C 42 and deduct cost from payment due.

3.6 NONCONFORMING CONCRETE

- A. Remove and replace areas that fail compressive strength tests, with concrete of thickness shown on Drawings.
- B. Replace nonconforming sections at no additional cost to Authority.

3.7 PROTECTION

- A. Maintain newly place concrete in good condition until completion of Work.
- B. Replace damaged areas.

END OF SECTION

Section 02811

LANDSCAPE IRRIGATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe and fittings, valves, sprinkler heads, and accessories.
- B. Control system.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for landscape irrigation will be made under this Section on lump sum basis.
 - 2. Payment for capped irrigation sleeve, for connection to future system expansion, is on linear foot basis.
 - 3. Refer to Section 01270 - Measurement and Payment.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ANSI/ASTM D 2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
- B. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure - Rated Pipe (SDR Series).

1.4 SYSTEM DESCRIPTION

- A. Electric solenoid controlled underground irrigation system.
- B. Source Power: 120 volt

1.5 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable code for piping and component requirements.

1.8 PRE-INSTALLATION CONFERENCE

- A. Convene one week prior to commencing work of this Section.

1.9 COORDINATION

- A. Coordinate work with site landscape grading and delivery of plant life.

1.10 EXTRA MATERIALS

- A. Furnish extra components under provisions of Exhibit 1 – Contractor’s Bid.
 - 1. Two sprinkler heads of each type and size.
 - 2. Two valve box keys.
 - 3. Two wrenches for each type head core and for removing and installing each type head.

PART 2 P R O D U C T S

2.1 PIPE MATERIALS

- A. Pipe shall be continuously and permanently imprinted with manufacturer's name, size, schedules, type, and working pressure.
- B. PVC Pipe ASTM D 2241; 200 psi pressure rated upstream from controls, 160 psi downstream; solvent welded sockets rubber gasket joints.
- C. Fittings: Type and style of connection to match pipe.
- D. Solvent Cement: ANSI/ASTM D 2564 for PVC pipe and fittings.
- E. Sleeve material: 4 inch schedule 40 PVC.

2.2 OUTLETS

- A. Manufacturer's or approved equal:
 - 1. Rainbird Model 1804.
 - 2. Rainbird Model 1812
 - 3. Hunter Model PGP
- B. Rotary type sprinkler head: Pop-up type with screens; fully adjustable for flow and pressure; size as indicated; with letter or symbol designating degree of arc and arrow indicating center of spray pattern.
- C. Spray Type Sprinkler Head: Pop-up head with full circle, half circle, third circle, quarter circle, and square pattern.

2.3 VALVES

- A. Manufacturer's or approved equal:
 - 1. Rainbird Model PEB Series
- B. Gate Valves: Bronze construction, non-rising stem, and sized to line.
- C. Backflow Preventers: FEBCO 765 Bronze body construction, reduced pressure zone or pressure vacuum breaker type.
- D. Valve Box and Cover: rectangular 10 inches by 4 inches or 9 inches round.

2.4 CONTROLLER

- A. Manufacturer's or approved equal:
 - 1. Rainbird Model RC1260C
- B. Valves: Electric solenoid wiring including required fittings and accessories.
- C. Wire conductors: color coded.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify site conditions under provisions of Section 01312 - Coordination and

Meetings.

- B. Verify location of existing utilities.
- C. Verify that required utilities are available, in proper location, and ready for use.

3.2 PREPARATION

- A. Piping layout indicated is diagrammatic only. Route piping to avoid plants, ground cover, and structures.
- B. Layout and stake locations of system components.
- C. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system.

3.3 TRENCHING

- A. Trench and filling as required.
- B. Trench size:
 - 1. Minimum cover over installed supply piping: 18 inches.
 - 2. Minimum cover over installed branch piping: 12 inches.
 - 3. Minimum cover over installed outlet piping: 12 inches.
- C. Trench to accommodate grade changes.
- D. Maintain trenches free of debris, material, or obstructions that may damage pipe.
- E. Do not leave trenches open overnight.

3.4 INSTALLATION

- A. Install pipe, valves, controls, and outlets in accordance with manufacturer's instructions.
- B. Connect to utilities.
- C. Set outlets and box covers at finish grade elevations.
- D. Install control wiring as required. Provide 10-inch expansion coil at each valve to which controls are connected, and at 100 foot intervals. Bury wire beside pipe. Mark valves with neoprene valve markers containing locking device. Set valve

markers in 160 psi PVC pipe risers exiting from top of valve to finish grade.

- E. After piping is installed, but before outlets are installed and filling commences, open valves and flush system with full head of water.
- F. Coordinate pipe installation with conduit installation.

3.5 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed.
- B. Prior to filling, test system for leakage for whole system to maintain 100 psi pressure for one hour.

3.6 FILLING

- A. Cover with 3 inches of sand over piping; fill trench and compact to subgrade elevation. Protect piping from displacement.

3.7 ADJUSTING

- A. Adjust control system to achieve time cycles required.
- B. Change and adjust head types for full water coverage as directed.

3.8 DEMONSTRATION

- A. Demonstrate system under provisions of Section 01755 - Starting Systems.
- B. Instruct Authority's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance material as basis for demonstration.

END OF SECTION

Section 02821

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Manual gates and related hardware.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for removing and replacing chain link fences and gates under this Section and as shown on Drawings will be by the linear foot. Pay item includes all materials and work to replace fence.
 - 2. Refer to Section 01270 - Measurement and Payment.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

- A. ANSI/ASTM A 123 - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
- B. ANSI/ASTM F 567 - Installation of Chain-Link Fence.
- C. ASTM A 116 - Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric.
- D. ASTM A 120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- E. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- F. ASTM A 392 - Zinc-Coated Steel Chain-Link Fence Fabric.
- G. ASTM A 428 - Weight of Coating on Aluminum-Coated Iron or Steel Articles.
- H. ASTM C 94 - Ready-mixed Concrete.
- I. ASTM F 573 - Residential Zinc-Coated Steel Chain Link Fence Fabric.

- J. ASTM F 668 - Poly (Vinyl Chloride) (PVC) Coated Steel Chain Link Fence Fabric.
- K. Chain Link Fence Manufacturers Institute (CLFMI) - Product Manual.
- L. FS RR-F-191 - Fencing, Wire and Post Metal (and Gates, Chain Link Fence Fabric, and Accessories).

1.04 SYSTEM DESCRIPTION

- A. Remove and replace chain link fabric and gate with new materials as required in this Section, match existing dimensions. Existing frame to remain in place.

1.05 SUBMITTALS

- A. Submit following Section 01330 - Submittal Procedures.
- B. Shop Drawings: Indicate plan layout, spacing of components, hardware anchorage, and schedule of components.
- C. Product Data: Provide data on fabric, accessories, fittings, and hardware that indicates items match or exceed the quality of existing items.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.07 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings. Match dimensions of existing fence frame.

PART 2 PRODUCTS

2.01 GALVANIZED FENCING

- A. Fence fabric shall be No. 9 steel wire, hot galvanized after weaving, to match or exceed existing fence fabric.
- B. Framework shall be hot-dipped galvanized with a minimum coating of 2 ounces per square foot, or one ounce per square foot plus 30 micrograms per square inch of chromate conversion coating.
- C. Line posts shall conform to ASTM A 570 Grade 45 steel or ASTM A 569, cold rolled steel.

- D. End corner, angle, and pull posts shall conform to ASTM A 570 Grade 45 steel or ASTM A 569 for steel pipe.
- E. Top rails shall be 1.65 x 1.25-inch formed C-section; or 1.6-inch round ASTM A 569, 1.35 pounds per foot; or 1-5/8-inch outside diameter steel pipe, 2.27 pounds per foot. Top rails shall pass through openings provided for that purpose in post tops.
- F. Fabric ties shall be hog rings, galvanized steel wire not less than 9 gauge with a zinc coating of not less than 1.2 ounces per square foot.
- G. Bolts and nuts shall be in conformance with ASTM A 307 and shall be galvanized in accordance with AASHTO M 232.
- H. Install horizontal braces fabricated of 1-5/8-inch, 2.27-pound copper bearing steel pipe at all corner, gate, and end posts.
- I. Gates shall be either swing or slide, as shown on the Drawings. Swing gates shall be hinged to swing 90 degrees or 180 degrees from closed to open. Slide gates shall be roller type with no vertical obstructions. All gate leaves shall have intermediate members and diagonal stress rods as required for rigid construction and shall be free from sag or twist. All gates shall be fitted with vertical extension arms or shall have frame end number extended to carry barbed wire. Gate posts for gates shall be 4-inch, 9.1-pound pipe. Gate frames shall be made of 2-inch outside diameter, castings. Fabric shall be the same as for the fence. Gates shall have malleable iron ball and socket hinges, catches, and stops.
- J. Provide padlocks with 2 keys each for each gate. Locks for multiple gates at a single location will be keyed alike. Posts for single gates shall be the same as end posts.

PART 3 E X E C U T I O N

3.01 INSTALLATION

- A. Install chain link fence in accordance with the directions of the manufacturer and these Specifications.
- B. Install fence posts at not more than 10-foot centers and at least 36 inches into the ground in a Class B concrete base. Allow concrete to cure for at least 7 days before erecting remainder of fence. Fasten fabric to line posts with wire ties spaced about 14 inches apart and to top rail spaced about 24 inches apart.
- C. Use standard chain link fence stretching equipment to stretch the fabric before tying it to the rails and posts. Repeat the stretching and tying operations every 100 feet or less.
- D. Erect gates so they swing or slide in the appropriate direction. Provide gate stops. Secure hardware, adjust, and leave in perfect working order. Adjust hinges and diagonal bracing so gates will hang level. Adjust rollers and guides of sliding gates so gates are level.

- E. At small natural or drainage ditches where it is not practical for fence to conform to contour of the ground, span the opening below the fence with wire fastened to stakes of required length. The finished fence shall be plumb, taut, true to line and ground contour. When directed, stake down the chain link fence at several points between posts.
- F. Where new fence joins an existing fence, set a corner post and brace post at the junction and brace as directed. If the connection is made at other than the corner of the new fence the last span of the old fence shall contain a brace.

END OF SECTION

Section 02822

FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fencing and gate materials for a complete galvanized coated welded wire mesh fence system and gates, including accessories and installation at Butterfly Valve Stations as shown on Drawings.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. No payment will be made for wire mesh fencing or gates under this Section. Include cost in lump sum price for BFV Vaults or other facilities.
- 2. Refer to Section 01270 – Measurement and Payment for lump sum price procedures

1.03 REFERENCE ASTM DOCUMENTS:

- A. A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile (414 MPa.).
- B. A 853 - Standard Specification for Steel Wire, Carbon, For General Use
- C. C 94 - Ready-Mix Concrete.
- D. F 567 - Standard Practice for Installation of Chain Link Fence.
- E. F 626 - Specification for Fence Fittings.
- F. F 900 - Specification For Industrial And Commercial Swing Gates.
- G. F 1043 - Specification For Strength And Protective Coatings On Metal Industrial Chain Link Fence Framework.
- H. F1916 - Standard Specifications for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications. (For grounding, reference only)

1.04 SYSTEM DESCRIPTION

- A. Fence height shall be as indicated on Drawings.
- B. Line post spacing shall not exceed 10 feet, or as shown on Drawings.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01330 – Submittals.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.
- C. Product Data: Provide data on fabric, posts, accessories, fittings, and hardware that indicates that items match or exceed the quality of specified items.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years experience.

1.07 FIELD MEASUREMENTS

Verify that field measurements are as indicated on shop drawings.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Strength requirements for posts shall conform to ASTM F 1043. The product of the yield strength and section modulus shall not be less than that for pipe conforming to ASTM F 1083.
- B. Products shall be new from recognized, reputable manufacturers. The manufacturers shall have a minimum of three years experience. Used, re-rolled or re-galvanized material is not acceptable.
- C. Welded Wire Fabric shall be fabricated from low carbon steel wire and electronically control welded, forming a specified mesh size.
 - 1. Manufacturer:
 - (a.) Riverdale Mills Corp., Northbridge, MA., Tel: 1-800-762-6374
 - Or approved equal.
- D. The wire shall conform to ASTM A 853 Grade AISI 1006, having a minimum tensile strength of 70,000 PSI (485 MPa.) After welding the fabric is hot-dipped, galvanized with a minimum 1.2 oz zinc/ft².

Note: Welded mesh is measured wire center to wire center, whereas, chain link mesh openings are measured inside to inside of the diagonal wires with 1/8" (3 mm) tolerance. i.e. Welded mesh wires located 2¼ inches on center (57 mm) and compared to 2 inch (51 mm) chain link have the same mesh openings.

E. Fabric Heights:

1. Perimeter Fences typically 8-16 feet or as required single panel construction ½" x 3" X 10.5 gauge. (12.7 mm x 76 mm x 3.25 mm) panel size 7'-3" wide x required height (2.21m).

F. Framework: Framework strength and coating shall be in accordance with ASTM F 1043.

1. Grade A Pipe, hot-dipped galvanized Schedule 40 pipe conforming to ASTM F 1043 Group 1A.
2. Grade B Pipe, Manufactured by cold rolling and radial frequency welding, the steel shall conform to ASTM F 1043 Group IC with a minimum yield strength of 50,000 PSI. (344.0 MPa.). Exterior and Interior coatings shall be in accordance with ASTM F 1043.
3. "C" post, manufactured by cold forming shall conform to ASTM F 1043 Group II with minimum yield strength of 60, 000 PSI. (413.7MPa) "C" post size 3¼ "x 2½" x .150 wall. (83 mm x 64 mm x 3.8 mm).
4. Wind loads: Post shall withstand 70 M.P.H. minimum wind load.
5. Manufacturers:
 - a. Gregory Galvanizing, Canton, OH. Tel: 330-477-4800
Or approved equal.
6. Post Sizes, determined in accordance with previous approved practices Line, terminal and gate post shall not be less than 95% of the nominal weight conforming to (ASTM F 1043 Group 1A, 1C. and 11.)
 - a. "C" Post 3¼" x 2½x 0.160 wall are acceptable
"C" line post with flat attaching bars used to secure welded mesh to post.
"C" post brackets spaced 15" on center. also acceptable for attaching welded mesh to "C" line post. 4" diameter tubular post shall be used as terminal post, exceptions may apply to gate post. (See Section 3.01-K)
7. Rail Size:
 - a. 1-5/8" diameter rails located at the top and bottom of the fence.
 - b. "C" rails 1.625 x 1.25 x 0.80" wall are acceptable for top and bottom rail locations.

- c. Secure welded mesh to rails with 9 gauge tie wires (Section 2.01 G 5,6, and 7).

G. Fittings and Accessories

1. Post Tops: Pressed steel or malleable iron, designed as a weather tight enclosure for tubular post. Weather tight enclosures not required for "C" post.

Provide one cap for each exposed tubular post end, unless equal protection is afforded by combining post top and barbed wire supporting arm if used. Post caps not required for "C" post.

2. Preformed Power Twisted Ties: Fabric attachment to rails, 9 gauge ties for fabric sizes 10.5 gauge and larger. Ties shall be aluminized with a minimum coating of 0.40 oz. aluminum/ft² or galvanized.
3. Tie Spacing for top rails are at intervals not exceeding 24", (bottom rail tie spacing intervals not to exceed 12".
4. Line Post and Terminal Post Brackets: Spacing for line and terminal posts are at intervals not exceeding 15" See drawing for bracket locations.

- H. Gates shall be swing type. Swing gates shall be hinged to swing 90 degrees from closed to open or hinged to swing 180 degrees from close to open. All gate leaves shall have intermediate members and diagonal stress rods as required for rigid construction and shall be free from sag or twist. All gates shall be fitted with vertical extension arms or shall have frame end member extended to carry barbed wire. Gate posts for gates shall be 4-inch, 9.1 lb pipe. Gate frames shall be made of 2-inch outside diameter, castings. Fabric shall be the same as for the fence. Gates shall have malleable iron ball and socket hinges, catches, stops and padlocks with 3 keys each. Posts for single gates shall be the same as end posts.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation of the Framework Components shall be in accordance with ASTM F 567 when applicable and as specified herein.
- B. Installation of Welded Wire Fabric components: follow the manufacturer's recommendations.
 1. Tolerance: Top to bottom of panel one inch post to panel misalignment tolerance. This tolerance covers those areas where minor grade change can be accommodated,

panels are out of square, occasional workmen's oversight and post out of plumb

- C. Site Preparation: Prior to the installation, all necessary grading and cleaning on both sides of fence shall be performed by the General Contractor or others responsible for site grading.
 - 0. Grading shall be done in such a manner as to provide a straight flat and level surface, Soil or stone fill shall be thoroughly compacted.
 - 1. All excavation shall be coordinated with respect to electrical and mechanical component installations. All existing utilities shall be located prior to starting excavation.
 - 2. Erect the fencing in straight lines between angle points. Erect framework in accordance with ASTM F 567 and as approved by shop drawings. All fencing shall be grounded as shown on the drawing and as specified herein. (3.1 M).
- D. Minimum Post Hole Diameter is 16" and Minimum Post Hole Depth is 48".
- E. Post Holes in Solid Rock or Concrete: Drill holes into solid rock or concrete 1/2" wider than pipe diameter, and 18" deep for end, corner and gate posts and 12" deep for line post.

Half-fill the void with non-shrinkable grout and force the post to the bottom of the hole, leaving no voids. Crown the grout to shed water. The use of sleeves in new concrete is recommended.
- F. Concrete Mix: Shall be in accordance with ASTM C 94 with maximum 3/4" aggregate, and having a minimum compression strength of 4000 Psi at 28 days. Concrete shall be thoroughly worked into the post holes leaving no voids.
- G. Allow concrete to cure a minimum of (7 days) before installing fence fabric or fittings. The top surface of the post footing shall have a crown water shed finish.
- H. Post Spacing: Space post equal distance in the fence line to a maximum of 96" on center. No terminal posts larger than line post required, except for gate post; welded mesh requires no stretching.
- I. Mow Strip: Continuous 24" x 6" concrete mow strip is to be installed along the entire length of the fence line as shown on Plans. Thickness of concrete increases to 12" between gate posts.
- J. Rails: Install rails as called for on the drawings and in these Specifications. All rails shall be installed on the side of the fence which is being protected to provide the least access for climbing. No corner bracing required for welded wire fabric installations
 - 0. Top rails, with the use of 7" sleeve, shall run continuously through the top caps or

extension arms. Bottom rails shall be connected to the line and terminal post using boulevards or bands and rail ends. Attachment bolts for bands shall be 5/16" x 1 ½" carriage bolts with nuts.

1. Boulevard bolts shall be 3/8" minimum in diameter. Bottom rails locations shall correspond with this specification and drawings.
 2. Two way brace bands and rail ends may be used in place of boulevards.
- K. Welded Wire Fabric General: Welded wire panels are fabricated to correspond with the widths and heights specified. Welded mesh panels are attached with a combination of brackets and tie wire in accordance with the drawing. Option (1) Continuous flat bar drilled 12" on center, running top to bottom of exposed fabric. Option 2 Preformed 1" x 10 gage thick two piece brackets, zinc coated are secured to the line post with 5/16" carriage bolts. Terminal post connections are comprised of tension bands. Band spacing not exceed 15" for terminal post. See corner connection detail for securing tension bands. Continuous punched "C" post and flat bar method preferred over round post.
- M. Grounding to the Earth: Grounding and bonding of the perimeter systems shall be in accordance with the N.E.C. (National Electric Code), N.E.S.C. (National Electric Safety Code) ASTM F 1916 and as specified herein.
1. Fences crossing power lines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing.

Where electronic detection is an integral part of the fence, grounding electrodes shall be installed at 200' intervals along the fence line. (For additional information consult with the electronic system manufacturer.)
 1. The grounding electrodes shall be a minimum 3/4" diameter x 10' long copper clad rod, driven into the earth until the top is 12 in below grade. Attach a No. 2 AWG bare stranded copper conductor by exothermically welding to the ground rods and extend underground in the immediate vicinity of the fence post.

Secure the grounding conductor to the post with 5/16" self-tapping galvanized or stainless steel bolts and approved copper compression terminal ends or clamps.
 2. After grounding connections have been completed, perform a ground resistance test in the presence of the Owner's Representative. The ground resistance shall not exceed 25 OHMS under normal dry conditions.

Where resistance requirements cannot be attained, install additional rods no closer than 6' on center. Install no more than two additional rods at each location.

- N. Erect gates so they swing or slide in the appropriate direction. Provide gate stops as required. Secure hardware, adjust, and leave in perfect working order. Adjust hinges and diagonal bracing so that gates will hang level. Adjust rollers and guides of sliding gates so that gates are level.
- O. At small natural or drainage ditches where it is not practical for the fence to conform to the contour of the ground, span the opening below the fence with wire fastened to stakes of required length. The finished fence shall be plumb, taut, true to line and ground contour. When directed, stake down the chain link fence at several points between posts.

END OF SECTION

SECTION 02893

TRAFFIC SIGNAL CONSTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This specification consists of the requirements to construct traffic signals in the City of Houston.

1.2 UNIT PRICES

- A. Items discussed in this specification shall be measured separately from the unit price items identified in Exhibit 1 – Contractor’s Bid. Items and work processes discussed in this section are incidental to furnishing and installing a functioning traffic signal.

No separate payment shall be made for Traffic Signal Construction under this Section. Payment will be included under various unit price items included in Exhibit 1 – Contractor’s Bid.

- 1. Measurement and payment of traffic signal items shall be per each unit furnished and installed complete and in place with all appurtenances.
 - 2. Payment for traffic control devices will be on the basis of each device installed as shown on the drawings or as directed by the Engineer/or the Resident Project Representative (RPR).
 - 3. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price per Intersection (Lump Sum)
If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 SPECIAL REQUIREMENTS

The requirements of this contract encompass the construction of new traffic signal installations either installed 1.) concurrent with the street or roadway improvement phases of the work so that the signals will be in operation at the time the intersection is open to traffic, or 2.) as traffic signal or traffic signal related improvements.

The purpose and intent of this specification is for the Contractor to furnish all labor, materials, tools, equipment, tests, adjustments and all other incidentals necessary to install and/or modify a traffic signal system. The Contractor shall also install items furnished by the Authority, specified herein. All materials and equipment furnished for installation under this contract shall be new and unused, unless otherwise specified.

Contractor shall furnish and install or install materials as specified herein.

All bidders shall visit the job site prior to bidding in order to acquaint themselves with all job site conditions and problems, if any, and all other factors that may affect the bid on all project specific contracts. On work order type projects, all bidders shall thoroughly familiarize themselves with the City of Houston and Harris County requirements and general field conditions. Any discrepancy between drawings and specifications shall be resolved prior to bidding.

These specifications together with the reference Drawings and Contract Documents require the furnishings of all superintendence, labor, tools, equipment and apparatus necessary for the complete working system of the traffic signal installation(s). All submittals need to be pre-approved prior to beginning the work, by the RPR and the Design Professional of Record (DPOR) as directed by the Engineer.

Email Traffic Signal Engineering and Operations, (citytrafficprojmgr@houstontranstar.org) for coordination and inspection of traffic signal work. Contractor is required to notify daily activities to City Traffic Signal Inspector via email (citytrafficinspector@houstontranstar.org) before 7:30 A.M.

All control equipment shall confirm to ITE and NEMA specifications and in accordance with the drawings and specifications.

All construction will be in accordance with the Texas Manual on Uniform Traffic Control Devices, latest revisions, and in accordance with the drawings and specifications.

All wiring throughout each traffic signal installation shall be in strict accordance with the National Electric Code, all local applicable codes and shall also comply with all requirements of CenterPoint Energy, in order that service may be obtained from them. All costs for code compliance are to be included in the bid for this contract.

1.4 REFERENCES

- A. References: References to known standard specifications in the Specification shall mean and intend latest edition of such specification adopted and published at date of invitation to submit Proposals.
- B. Reference to technical society, organization or body is made in Specifications in accordance with the following abbreviations:

AASHO	American Association of State Highway Officials
ACI	American Concrete Institute
* AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction

AISI	American Iron and Steel Institute
ASA	American Standards Association
ASTM	American Society for Testing and Materials
AWSC	American Welding Society Code
FS	Federal Specification
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
ITE	Institute of Traffic Engineers
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Association
UL	Underwriters' Laboratories
* IEEE	Institute of Electrical and Electronics Engineers – name changed from AIEE & IRE (Institute of Radio Engineers)

1.5 PERMITS, LAWS, CODES, ETC.

The contractor and subcontractors shall comply with all Federal, State and local Laws, Codes and Ordinances applicable to the work and all requirements of the National board of Fire Underwriters having jurisdiction. If the above laws, codes or ordinances conflict with specification, then the laws, codes or ordinances shall govern except where Specification exceeds them in quality of quantity of materials or labor. Obtain and pay for all permits required in connection with the execution of the work as required. The Engineer and the RPR shall be furnished with certified copies of these permits if requested.

1.6 COOPERATION WITH BUILDING OFFICIALS

Cooperate with local and other governmental officials and inspectors at all times. If such official or inspector deems special inspection necessary, provide assistance and facilities that will expedite their inspection. Any materials and or workmanship which are rejected by the Traffic Signal Inspector by reason of failure to conform to the requirements of the drawings or specifications, shall be removed and replaced by the contractor at their own expense.

1.7 SUBSTITUTIONS

- A. Except in special instances, the Technical Sections of these specifications list more than one manufacturer of the products specified. Products of listed manufacturers conform basically to design and performance requirements as indicated on the Drawings and specified herein and Contractor in proposing their use shall indicate by detail drawings and/or descriptive data any modifications of items or assemblies necessary to provide

the indicated and/or specified work.

- B. Requests for substitutions of materials must be submitted in writing to the Engineer and the RPR by the Contractor. These substitutions will only be considered if fewer than three manufacturers are listed in the Specifications.
- C. Under no circumstances will the Engineer or the RPR be required to guarantee or certify that a product proposed for substitution is, or is not, of equal quality to the product specified. It is mandatory that the Contractor submit to the Engineer and the RPR, in Writing, all evidence necessary to support this contention that the item proposed for substitution is equal to the item indicated by the Contract Documents. Items submitted for substitution must be submitted one month prior to bid opening.

1.8 MANUFACTURER'S SPECIFICATION AND INSTRUCTIONS

Install all manufactured items, materials and equipment in strict accordance with the manufacturer's recommended specifications except that the Specifications herein, where more stringent, shall be complied with.

1.9 MEASUREMENTS

Before doing any work or ordering any materials, the Contractor and Subcontractors shall verify all measurements of existing and new work and shall be responsible for their correctness. Any difference which may be found shall be submitted to the Engineer and/or the approved Authority Representative for consideration before proceeding with the work. No extra compensation will be allowed because of differences between actual dimensions and measurements indicated on the drawings.

1.10 RECORD DRAWINGS

Provide and maintain in proper order and in good, clean condition at the project sites, one complete set of prints of all project drawings. On this set of drawings, the Contractor shall neatly print and accurately inscribe, in red pencil, any and all changes or deviations from construction and installation as originally indicated in the plans and specifications. This set of prints shall be delivered to City of Houston Traffic Management and Maintenance at TranStar Third Floor, 6922 Old Kay Road, or the Harris County Department of Engineering (as may be applicable), at the time of final acceptance of the work by the City or Harris County in order to provide the City or Harris County with an "AS BUILT" set of plans.

1.11 TEMPORARY FACILITIES

A. Weather Protection

- 1. Contractor shall at all times provide protection against weather, so as to maintain all work, materials, apparatus, and fixtures free from injury and damages. At the

end of the day's work, all new work likely to be damaged shall be covered or otherwise protected.

2. Wet work shall not be performed when temperature is below 40° F, or is likely to go below 40° F, within the ensuing 48 hours, except when sufficient protective heat is provided and the Engineer's and/or the approved Authority Representative's approval in writing is obtained.
 3. Contractor shall construct and maintain all necessary temporary drainage and do all pumping necessary to keep excavations, pits and trenches free of water.
- B. Operation of Equipment
- When electrical or other equipment is installed, it shall be the responsibility of the Contractor to check out same for a period of time as required by the Engineer or the RPR for proper testing of the equipment. All items of equipment, testing instruments and incidentals necessary for proper testing of equipment shall be furnished by Contractor.
- C. When any temporary facility is no longer needed for the proper conduct of the work as determined by the Engineer or the RPR, the Contractor shall completely remove it from the project and shall repair or replace all material, equipment and finished surfaces damaged in doing so.
- D. Contractor shall provide a portable toilet as needed.

1.12 PROTECTION

Provide barricades, fences, lights, etc., for protection of property and the public as required by local and/or State Ordinances. Contractor will be held liable for all damage to property and/or persons.

- A. All barricades and signs shall conform to Texas MUTCD. Such barricades and protective signs shall be provided by the Contractor at their expense.
- B. Flow of traffic shall not be interrupted completely without the approval of the Engineer or the RPR. Restriction and minor diversion will be kept to a minimum. No work will be permitted in the traffic lanes during peak hours from **7:00 to 9:00 AM and 4:00 to 6:00 PM Monday through Friday**. Any open cuts in the intersections during these hours will be covered with steel plates to maintain uninterrupted traffic.
- C. Flagmen shall be certified flagmen or off-duty uniformed peace officers of the law. Contractor shall provide flagmen to direct traffic when directed by the Engineer or the RPR or the approved City Representative of the Traffic Management and Maintenance Division (if applicable). This does not relieve Contractor of

responsibility of taking other steps and providing other personnel who he may deem necessary for protection of work and public.

- D. Appropriate Personal Protective Equipment shall be worn by all contract personnel when on the job-site.

1.13 RESTORING DAMAGED AREAS

For all work at identified intersections and along communication cable routing, in the event that sidewalks, pavement, curbs, wheelchair ramps, driveways, landscaped areas, areas with special pavement treatment, sprinkler systems, lighting systems, or other items or properties both public and private that are damaged during this construction, shall be restored to their prior condition without expense to the Authority. No separate payment will be made for the restoration of these items.

Where signal poles are installed inside the existing 4 foot sidewalk or within 12 inches of either side of the existing sidewalk, the Contractor shall provide a minimum of 4 foot paved sidewalk 12 inches away from edge of the signal pole. The horizontal slope for the sidewalk shall be 2 percent.

PART 2 PRODUCTS

2.1 MATERIALS

Contractor is responsible for furnishing all materials and labor for construction of items as shown on drawings and other incidentals necessary to provide a fully operational traffic control signal. The Contractor shall furnish and install all materials, with exception of materials to be provided by the Authority.

Material should be installed according to the technical specifications and standard details under the observation of the Engineer or the RPR.

In addition to all items to be furnished and installed by the Contractor, the Contractor shall furnish and install all items necessary for the complete signal system including but not limited to the following incidental materials:

All conduit nipples, couplings, grounding bushings, elbows, sweeps and service heads.

All reinforcing steel and ties.

Concrete, sand, cement, gravel, asphalt, earth fill.

Span guy, down guys, anchor rod assemblies.

Sidewalk guy assemblies (if necessary).

Guy guards, three bolts clamps, lag screws.

5/8" Thru-bolts, nuts, washers, thimble-eye nuts and bolts.

5/16" Stranded galvanized steel cable for guys and catenaries.

1/4" Stranded galvanized steel cable for messengers.

Strand vises and links as needed.

Meter loop assemblies complete.

Signal mounting hardware.

Copperweld ground rods and clamps furnished and installed in all foundations and each pullbox.

Flexible stainless steel cable strap ties. Cable ties shall be Panduit Part #MLT 4H-LP or equivalent.

#6 or #8 Soft bare copper wire for grounding poles, conduits, etc.

Miscellaneous hardware.

Interconnect cable shall be communications grades as follows:

Type PE-38 or PE-22 (aerial)

Type PE-39 (underground)

All proposed changes in the signalization plan must be submitted to the City of Houston, in writing, for approval.

The Contractor shall be responsible for the protection of all present utilities that have been located by the various utility companies. They shall also maintain and protect the existing traffic signals and their related equipment from damage caused by subcontractors and employees under his Contract but only to the extent of the Contractor's normal work operation, and he shall not be responsible for routine maintenance, normal wear and tear, or an act of God, unless otherwise specified.

The contractor shall bag all newly installed signal heads and/or pedestrian signal heads with burlap until final inspection and acceptance by the City of Houston or Harris County Representative. The signal shall be wrapped with burlap at least twice so that the entire signal head is covered, and cannot be seen until it is placed in operation. The signal shall be de-energized while not in use. If, in the opinion of the Engineer or the RPR, the new heads would create a hazard condition to motorists and/or pedestrians, the heads shall not be installed until one hour before turning on the new equipment.

All existing traffic signal equipment removed by the Contractor shall be tagged to identify location. A representative of the City's Traffic Signal Engineering and Operations or Harris County shall be given **24 hour** notice before delivery of an approval location by the Engineer or the RPR. Equipment not identified will not be accepted and equipment not returned will result in the withholding of payment to the Contractor. The City's Traffic Signal Engineering and Operations personnel will issue a receipt to Contractor for returned equipment.

When the City Traffic Engineer or the approved City of Houston Representative or Harris County Representative determines that the need for a traffic signal is critical to the public welfare, early "turn on" of the signal shall be required before the completion of the project. If the need arises, the City of Houston or Harris County will assume the responsibility for maintenance and liability, or negotiate with the Contractor for maintenance and liability for such a signal.

The City Traffic Engineer or the RPR may, at any time, authorize City of Houston or Harris County personnel to enter the controller cabinet in order to restore any and all signal equipment to proper operation if the malfunction or non- function of such equipment poses a hazard or inconvenience to motorists or pedestrians. Such authorized entry may occur at any time within the period of the Contract and such authorized entry shall in no way relieve the Contractor or manufacture of their respective warranties.

During the burn-in period, the Contractor shall restore operation of the installation within **four (4) hours** after notification of a malfunction. If the Contractor does not respond within **four (4) hours**, the Authority shall have the option of making the necessary repair and billing the Contractor for the actual time and materials required.

When replacing sidewalks or curb and gutters, it shall be the responsibility of the Contractor to reinstall them to match existing color and/or surface texture.

Materials specified herein shall be installed as per Traffic and Transportation Construction Details drawings-02893 series and the City of Houston Traffic Signal Standard Specifications.

The Contractor shall be responsible for having an authorized manufacturer representative of traffic control equipment present as per the requirements of Specification Section 01755, "STARTING SYSTEMS".

Each work order or intersection shall be a stand alone "Turn Key Job" by the Contractor.

A steel template of the proper dimensions shall be furnished and used by the Contractor to secure anchor bolts while constructing pole foundations.

Flexible stainless steel cable ties for strapping signal cable to messenger shall be min: 13.38 inches long, 120 lb. min. tensile holding strength, 3/16" to 3-1/2" wire bundle range. (Panduit Part #MLT 4H-LP or approved equal).

2.2 PRECONSTRUCTION MEETING

The Engineer or RPR shall schedule a Preconstruction Meeting after award of contract and prior to commencement of construction. The Contractor or his authorized representative will be required to attend.

2.3 MATERIALS FURNISHED BY THE CITY

Prior to material pick up, a written notice is required sixty (60) calendar days in advance. This letter shall be addressed to:

**City of Houston - Traffic Signal Engineering & Operations
Traffic & Transportation Division
6922 Old Katy Road (Houston TranStar)
Houston, Texas 77024**

Materials furnished by the City shall be picked up by the Contractor at the Traffic Operations Center, 2200 Patterson Street, Houston, Texas 77007, after giving a minimum of two (2) working days notice to the City of Houston by emailing to: (citytrafficprojmgr@houstontranstar.org). This is in addition to the written requirements listed above. These materials will be furnished at no cost to the Contractor.

Any and all material furnished by the City to the Contractor which is not used in this contract is the property of the City of Houston and shall be returned to the locations specified by the Traffic Signal Inspector before final payment is made to the contractor.

2.4 PRODUCT DATA, SHOP DRAWINGS, AND SAMPLES

Contractor shall provide **three (3)** complete bound sets of Product Data, including: illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate materials or equipment for all Contractor furnished equipment.

Contractor shall furnish shop drawings, as required in the standard specifications and standard details, or as required by the Engineer and/or the approved City of Houston

Representative. As a minimum, Contractor shall be required to furnish shop drawings for all structural elements, including cabinets, traffic signal poles, traffic signal arms, luminaires, luminaire supports, vehicular traffic signal head mounts, and pedestrian signal head mounts **prior** to ordering or fabricating these elements. Shop drawing submittals are required for each of the preceding elements. Contractor is not required to furnish shop drawings for any equipment furnished by the City of Houston.

Contractor shall furnish samples, or prototypes, of the following equipment within the specified time frame.

<u>Item</u>	<u>Calendar Days from Bid Award</u>
Controller Cabinet Assembly	45
Traffic Signal Controllers	60

PART 3 EXECUTION

3.1 OPERATION OF NEW & EXISTING TRAFFIC SIGNALS DURING CONTRACT PERIOD

To facilitate construction, the Contractor shall be required to install temporary poles, guys, cables, signals, conduits, wiring and adjustments as needed for temporary traffic signal operation during construction. **The Contractor will be responsible for furnishing and installing all materials as directed by the City of Houston Signal Inspector for temporary traffic signal installation.** The Contractor shall contact the signal inspector assigned to the project with a daily progress report. The Contractor shall coordinate and obtain approval from the City of Houston signal inspector for all material as well as the configuration of the temporary traffic signal prior to installation. Proposed configurations and materials for the temporary traffic signal installation shall be submitted to the City of Houston Traffic Signal Engineering and Operations **no less than five (5) working days** prior to implementation. Operational timing and phasing of the temporary traffic signal installation during construction will be the responsibility of the City of Houston Traffic Management & Maintenance Branch personnel. Temporary traffic signal work will not be paid for directly, but shall be considered incidental to Traffic Control during construction. All temporary facilities shall be removed as directed by the signal inspector and remain the property of the Contractor upon operation of the new traffic signal construction.

The Contractor shall maintain existing signal installation(s) operation during construction of the new signal system. The Contractor may be required to photograph the existing signal to document existing status and functionality of all signal hardware and devices before beginning construction. It is the Contractor's responsibility to maintain all existing signal hardware and devices including signal heads and bulbs, interconnect, pedestrian elements, etc. The Contractor will not be responsible for power consumption of the signal during construction, and for work with the controller or inside the cabinet unless a city representative is onsite or as directed otherwise by the City of Houston. The Contractor shall submit all existing intersection documentation to the city inspector for the project before commencing work. The Contractor shall respond within **two (2) hours** after notification from appropriate Authority personnel. If the Contractor does not respond, the Authority will make necessary repairs and bill the contractor at an overtime rate (1.5X) for work performed.

The Contractor shall provide a minimum of five (5) working days notice to City of Houston representative at 713-881-3172 when seeking approval for a change in location, method of operation of traffic signals or traffic lanes, or change in traffic patterns or timing plans.

The Contractor shall provide a minimum of two (2) days notice when seeking approval regarding the replacement of an existing traffic signal installation.

The Signal Contractor shall be billed for any repair work performed on overtime (1.5X) for any repairs required because of Contractor negligence.

Uniformed Police Officers shall be employed by the contractor and are required to be

on the job site. It shall be mandatory to have Uniformed Police Officer(s) for traffic signal turn-ons. Certified flagmen or Uniformed Police Officers may be used, as needed, for lane closures. It is the Contractor's responsibility to use the appropriate personnel for lane closures. The Texas Manual On Uniform Traffic Control Devices will be observed for all lane closures.

All work in this contract, requiring signal outages, or lane closures, shall be performed between the hours of 9:00 A.M. and 4:00 P.M. Monday through Friday, unless prior authorization has been obtained from the Engineer and/or the approved Authority Representative.

Down time, if any, shall be kept to an absolute minimum. The switch over from the old system, or signal turn-on, shall be accomplished within the **six (6) hours between 9:00 A.M. and 3:00 P.M.** Contractor shall furnish and install all temporary traffic control (stop signs, flagmen, uniformed officers, etc.) during any down time, in addition to all required construction signs. Contractor shall inform the city of Houston to schedule a turn-on date **a minimum of 72 hours** in advance of need.

The Contractor shall hire a traffic engineer approved by the Authority to implement the traffic signal timings for the temporary signal system(s) and any modifications to the traffic control plan.

The Contractor shall furnish the Authority with a 24-hour telephone number for the purpose of forwarding malfunction calls. In the event that the Contractor cannot be reached at the above mentioned number, the City of Houston will take the necessary action to restore the traffic signal system to normal operation and all expenses incurred will be deducted from the final payment of the work order. All City of Houston labor expense shall be billed at overtime (1.5X) rates.

Contractor will be required to respond immediately and to initiate emergency maintenance operations on the jobsite a **maximum of four (4) hours** after the call is received from City of Houston. The Contractor shall pursue repairs to the traffic signal system and have it back in normal operation within a **maximum of six (6) hours** after call is received by the City of Houston, or a representative of the City of Houston.

3.2 CHARACTER OF WORKMEN AND EQUIPMENT

All equipment and workmen provided by the contractor for work hereunder shall be the best available for the kind of work being performed. Any person employed by the Contractor whom the Authority may deem temporarily or permanently incompetent or unfit to perform the work, shall under written instruction of the Engineer and/or the approved Authority Representative be removed from the job, and such person shall not again be employed on the work. Failure by the Contractor to provide adequate equipment may result in annulment of this contract as herein provided.

3.3 ELECTRICAL WORK

Electrical work is defined as installing cables, electrical terminations, and signal turn-ons. Installation of conduits is EXCLUDED from electrical work. Installation of loop wire in sawcut is EXCLUDED from electrical work.

All Contractor personnel working on City of Houston traffic signals performing duties directly involving setting up or installing signs, signals, pushbuttons, or traffic control shall be International Municipal Signal Association (IMSA) certified Level I, or greater. An IMSA certified Level II technician shall be present on site during all cabinet terminations and during the installation of all signs, pavement markings, signals, pushbuttons, and traffic control.

3.4 SALVAGED MATERIALS

At existing traffic signal installations which are to be updated or modernized by the Contractor, all abandoned wire, cable, signals, poles, pole bases, pole tops, mast arms, signs and other miscellaneous equipment shall be taken down and/or removed. All equipment shall be reduced to simplest form. These salvaged materials are the property of the City of Houston and are to be delivered and unloaded to the location or locations designated by the City of Houston Traffic Signal Inspector assigned to the project.

3.5 ELECTRICAL SERVICE

The Contractor shall notify the City of Houston Traffic Signal Inspector assigned to the project **within seven (7) days of Contractor award** for power at intersection.

3.6 SUBCONTRACTING

If a vendor subcontracts any portion of a contract for any reason, they must include, in writing, the name and address of the subcontractor, name of the person to be contacted including telephone number and extent of work to be performed. This information is to be submitted with bid proposal. In the event of a change during construction, Contractor is required to submit new information to the Engineer or the RPR, for approval, **five (5) days** prior to using the subcontractor on the job. Authority reserves the right to reject a bid of any bidder if the bid names a subcontractor who has previously failed in the proper performance of an award or failed to deliver on time contracts of a similar nature, or who is not in a position to perform properly under this award. Authority reserves the right to make determination as to the foregoing.

3.7 SYSTEM GROUNDING

All poles, cabinets, conduits, signal common, and service common shall be bonded with a No. 8 AWG bare copper wire, or equal, to form a continuous system and

effectively grounded to 5/8-inch x 8 foot copperweld ground rods.

3.8 STRANDED GALVANIZED STEEL CABLE

Guy, messenger and catenary wires shall be Siemens Martin Grade, seven strand, galvanized, high strength steel cable, 5/16 inch diameter for guy and catenary wires and ¼ inch diameter for messenger wires.

3.9 POLE RAKING

Poles shall be set with a sufficient amount of rake so that they are plumb with the signal load or slightly raked away from the signal load. Cantilever pole structures and 4-1/2" OD steel poles should be plumb, strain poles should have a slight backward rake (1 to 2 inches); wood poles shall utilize down guys to maintain appropriate signal height clearance during construction. The Contractor shall rake the poles to the satisfaction of the Traffic Signal Inspector.

Rake is hereby defined as the inclination to the vertical measured at the top of the structure in the opposite direction of the strain axis.

3.10 ABANDONED FOUNDATIONS

The tops of unused foundations shall be removed to a depth of two feet (minimum) below grade and back-filled according to specifications.

3.11 LOADS AND STRESSES DUE TO CONSTRUCTION OPERATIONS

Contractor shall have full responsibility for preventing over-stresses of any structure, cables, poles or any part of them during construction. This also applies to existing work facilities affected by his operations. The Contractor shall fully check the effect of his operations in this regard, and shall provide temporary supports and connections required to assure safety and stability of both new and existing work to prevent over-stress of any part thereof.

3.12 APPARATUS LOCATION

The locations of all poles, controllers, actuators and signals shown on the plans are diagrammatic only. The specific locations of such devices shall be decided by the appropriate design personnel and shall be staked out under their direction. Vehicular and pedestrian traffic signals shall be placed and aligned as the City of Houston Traffic Signal Inspector directs.

3.13 CONCRETE POUR

The time of day of the concrete pour shall be stipulated by the Contractor.

3.14 SEQUENCE OF WORK

Each new signalized intersection shall be in operable condition including electrical service within **fourteen (14) days** after the first signal pole is installed, unless conditions caused by a paving contractor or roadway construction contractor prevents the completion of the intersection(s).

The order in which the intersections are to be completed may be specified by the Engineer and/or the approved RPR and it shall be the sole responsibility of the Contractor to schedule and coordinate their work. All work shall be coordinated in such a manner as to prevent delays resulting from work to be performed by others and to complete his work within the specified time.

On the day when the intersection is to be turned on or its “Turn On” date, the Contractor will be given a “punch list” from the Signal Inspector for any items that need attention concerning the conditions of signal equipment. These items shall be completed within **ten (10) days** of the date on the “punch list” given to the contractor.

3.15 UTILITY COORDINATION

The Contractor shall contact the Lone Star Notification Center (713-223-4567, in Houston, 800-669-8344, outside Houston) **72 hours** before commencing any work to locate any utility lines in the construction area. It is the Contractor’s responsibility to physically locate any water and sewer lines and to adjust the location of any foundation(s), for approval by the City of Houston Traffic Signal Engineering and Operations.

3.16 UNDERGROUND UTILITIES

The exact location of underground utilities and pipelines is not certain. The Contractor shall contact the Utility Coordinating Committee (U.C.C.) to determine exact locations of underground utilities prior to drilling for foundations or any other work that might interfere with or damage present facilities. Contractor shall be responsible for keeping the transmittal number from the U.C.C. current during construction.

3.17 LOCAL CONDITIONS

The Contractor shall make any additional investigations he deems necessary to properly bid any and all work related thereto. No additional compensation will be made available to the Contractor for work arising from failure to examine the site and/or subsoil conditions. Staking of specific locations by the Engineer or the RPR shall not remove the Contractors responsibility for any damage caused by the Contractor to any underground utility.

3.18 RIGHTS OF VARIOUS INTERESTS

Wherever work being done by the City's forces or by any other Contractor is contiguous to work covered by this contract, the respective rights of the various interests involved shall be established by Engineer or the RPR, to secure completion of the various portions of the work in general harmony.

3.19 TRENCHING

No trenching shall be allowed within five feet of a tree.

3.20 DIRECTIONAL DRILLING, BORE, AND JACK

No open cutting or trenching of streets, driveways and sidewalks shall be allowed without prior approval of the Engineer or the RPR at each location. All conduit runs under streets, driveways or sidewalks shall be by directional drilling, bore, or jack. Water jetting methods shall not be accepted.

3.21 PUBLIC SAFETY AND CONVENIENCE

All work done under this contract shall be done in compliance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD). Each operation shall be considered a work zone area and shall be treated in accordance with the TMUTCD.

The Contractor shall have a Certified Worksite Traffic Supervisor who will be responsible for initiating, installing, and maintaining all traffic control devices as described in the TMUTCD. The Worksite Traffic Supervisor shall have at least one (1) year of experience directly related to worksite traffic control in a supervisory or responsible capacity and shall be certified by the American Traffic Safety Services Association or International Municipal Signal Association. The Worksite Traffic Supervisor will be incidental to Maintenance of Traffic and will not be measured separately for payment.

The Worksite Traffic Supervisor shall be available on a **twenty-four (24) hour day** basis and shall review the project on a day to day basis as well as being involved in all changes to traffic control. The Worksite Traffic Supervisor shall have access to all equipment and materials needed to maintain traffic control and handle traffic related situations. The Worksite Traffic Supervisor shall insure that routine deficiencies are corrected with a **twenty-four (24) hour** period.

The Worksite Traffic Supervisor shall be available on the site within **forty-five (45) minutes** after notification of an emergency situation, prepared to positively respond to repair the work zone traffic control or to provide alternate traffic arrangements.

Failure of the Worksite Traffic Supervisor to comply with these provisions may be grounds for decertification or removal from the project or both. Failure to maintain a designated Worksite Traffic Signal Supervisor or failure to comply with these

provisions will result in temporary suspension of all activities except traffic and such other activities deemed to be necessary for project maintenance and safety.

The Contractor shall at all times so conduct their work as to insure the least possible obstruction to normal pedestrian and vehicular traffic including access to all public and private properties during all stages of construction, and inconvenience to the general public and the residents in the vicinity of the work, and to insure the protection of persons and property, in a manner satisfactory to the City Engineer and/or the approved Authority Representative.

The Contractor shall provide all barricades and take all necessary precautions to protect buildings and personnel. All work shall be complete in every respect and accomplished in a workmanlike manner and contractor shall provide for removal of all debris from Authority property.

The successful bidder shall at all times guard against damage or loss to the property of the City of Houston or of other vendors or contractors and shall be held responsible for replacing or repairing any such loss or damage. Any damage to landscaping in the work area, including sod shall be replaced at the Contractor's expense.

Prior to closing any section of the project to traffic, the Contractor shall furnish, erect and maintain barricades and warning signs at and in the vicinity of all construction projects at all times, both day and night, during the construction period of the contract, and all such barricades and warning signs, shall be in conformance with the requirements of Part 6 Temporary Traffic Control of the Texas Manual on Uniform Traffic Control Devices and as shown on the drawings.

Unless otherwise set forth in these specifications, the Contractor shall receive no direct compensation for furnishing, erecting, and maintaining the necessary barricades, lights, flares, signs, or for any other incidentals necessary for the good and proper safety, convenience, and direction of traffic during the period prior to final inspection and acceptance by the City of Houston.

3.22 SPECIAL REQUIREMENTS

- A. A Steel Template shall be furnished by and used by the Contractor to secure anchor bolts while constructing pole foundations.
- B. Pole Foundations shall be capped where needed, in order to provide a smooth, flat, and level surface. Capping shall consist of a one (1) inch thick mortar cap prepared with a 1:3 sand-cement mortar ratio. The cap shall be steel trowel finished.
- C. Extra-length Concrete Pole Foundations shall be provided when required by site conditions. Reinforcing steel shall be increased by the same length as the increase in foundation length. Rods shown on Foundation Details shall be increased as follows: Each extra foot of foundation shall require on additional foot of length for hooked rods and two additional turns for helix.
- D. All Special Foundations shall be designated and approved by the Engineer, Design Professional of Record (DPOR) or the RPR.
- E. Sono Tube shall be used when the City of Houston Traffic Signal Inspector deems it necessary.

3.23 CONCRETE FINISHING

Honeycombed surfaces or other defects shall be patched with mortar of the same consistency as the mortar from which the concrete is made. Such mortar shall be well trowelled and then floated to remove trowel marks.

- A. Finish for Formed Surfaces. After patching above specified, exposed formed surfaces shall be finished by removing form marks, fins and other projections.
- B. Finish for Uniformed Surfaces
 - 1. Patches in streets, driveways and walks shall be finished to match adjacent surfaces.
 - 2. Surfaces not Otherwise Specified – Steel trowel finish.

3.24 CONCRETE CURING

Immediately after placing or finishing, concrete surfaces shall be protected against moisture loss for **a minimum of seven (7) days**. Wet earth, waterproof paper, vinyl sheets or cotton mats shall be placed over concrete during curing period in order to insure fulfillment of this requirement. Membrane curing method may be used **EXCEPT when** concrete surfaces are to receive additional concrete or mortar, or are to be painted.

3.25 CONCRETE/PAVEMENT REPAIR

Repairs to concrete pavement shall be in accordance with Public Works Drawing Numbers 02902-01 and 02902-02 titled, “Pavement Repair Details for Street Cuts”, and Specification Section 02951, “Pavement Repair and Resurfacing”.

3.26 FLEXIBLE BASE PAVEMENT REPAIR

Repairs to flexible base pavement shall be made in accordance with Public Works Drawing Number 02902-01 titled, “Pavement Repair Details for Street Cuts”, and Specification Section 02951, “Pavement Repair and Resurfacing”.

3.27 TRAFFIC SIGNAL TESTING SERVICES

- A. PROCEDURES
 - 1. Selection:
Authority shall employ an Independent Testing Laboratory to ensure Contract Document compliance.
 - 2. Test Reports

Testing laboratory will furnish reports to the Engineer, DPOR, Structural Engineer, RPR, and Contractor covering all of its determinations and all of its control services. Reports will show all data customarily listed by the laboratory in reporting such tests including daily reports on quantities and types of materials together with location in the project. Form of reports will be as approved by the Engineer or the RPR.

3. Test Methods

Tests and inspections will be conducted in accordance with the requirements of these Specifications or, if not herein specified in accordance with the latest standards of the American Society for Testing and Materials or other recognized authorities.

4. Contractor's Responsibility

(a) Cooperate with the testing laboratory and:

- (1) Make available, without cost, samples of all materials to be tested.
- (2) Furnish such normal labor as is necessary to obtain samples at the project and to assist in making slump tests and casting and curing cylinders.
- (3) Advise the laboratory of the identity of material sources and instruct these suppliers to allow inspections by the laboratory, and notify the laboratory sufficiently in advance of operations to allow for completion of initial tests and assignment of inspection personnel.

(4) Contractor shall provide laboratory testing for each different concrete load.

(b) Rejected Materials and/or Workmanship

If, after initial tests have been performed, any materials and/or workmanship are rejected by the testing laboratory, Contractor shall

- (1) pay for any subsequent testing required for materials which have been rejected and/or replaced.

Any materials and/or workmanship which are rejected by the testing laboratory by reason of failure to conform to the requirements of the Drawings and/or Specifications, shall be removed and replaced with new acceptable materials by the Contractor at his own expense.

5. Additional Responsibility

- (a) The testing of all cable furnished shall be properly tested by the manufacturer and data submitted through the Contractor to the Engineer and the RPR.
- (b) All cable furnished to the job site shall be properly tested on the reel use.

3.28 PRELIMINARY WORK

A. PROCEDURES

1. City Requirements

- (a) City requirements relating to the work of this section shall be ascertained by the Contractor. Contractor shall comply with all such requirements, including those relating to continued maintenance until completion of the project.
 - (1) If the City should require that certain portions of the work be performed by City personnel and equipment, all costs in connection therewith which are chargeable against the project shall be paid by the Contractor as an obligation of this Section
 - (2) If re-routing of vehicular and/or pedestrian traffic is necessary to complete work of this Contract, Contractor shall submit a copy of his proposed re- routing plan to the City and the Engineer and/or the approved Authority Representative for approval **seventy-two (72) hours** before proceeding with the work.
 - (3) Re-installation and restoration of use of existing public and private installations, which are temporarily and/or permanently removed and/or relocated for work of this Contract, shall be performed as a part of the work of this Section
- 2. Existing Installations of City-Owned Property
 - (a) Perform all work relative to removal, storage and/or protection of existing installations of street lights and signs, fire hydrants, manholes, and other existing installations in the way of project construction.
 - (b) Provide and maintain approved temporary protection of existing installations until project completion and acceptance. Remove temporary protection when, and as, directed by the City.
 - (c) Existing facilities which are no longer required shall be disconnected as directed. Comply with the requirements of municipal agencies having jurisdiction over such work.
 - (d) Unless otherwise directed, all abandoned facilities shall be removed by Contractor and the holes and trenches filled with approved compacted fill.

3.29 GUARANTEES

All items installed under this specification, having a manufacturer's guarantee shall be installed by or under the direction of the manufacturer or his certified agent, when so required to conform with the manufacturer's guarantee, and all such manufacturer's guarantees, warranties and bonds shall be forwarded to the RPR.

The Contractor, by accepting this contract, guarantees all workmanship, materials and equipment performed or furnished and installed under this specification for a period of one year from date of completion and shall, at their entire expense and within said term of guarantee, repair, replace or adjust all faulty, broken, or maladjusted materials and/or

equipment furnished and installed under this specification, including lamp replacement.

END OF SECTION

Section 02911

TOPSOIL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Furnishing and placing topsoil for finish grading and for seeding, sodding, and planting.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for topsoil under this Section. Include payment in Section 02921 - Hydro Mulch Seeding or Section 02922 - Sodding.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

PART 2 P R O D U C T S

2.1 TOPSOIL

- A. Topsoil shall be fertile, friable, natural sandy loam surface soil obtained from excavation or borrow operations having following characteristics:
 - 1. pH value of between 5.5 and 6.5
 - 2. Liquid limit: 50 or less
 - 3. Plasticity index: 20 or less
 - 4. Gradation: maximum of 10 percent passing No. 200 sieve
- B. Topsoil shall be reasonably free of subsoil, clay lumps, weeds, non-soil materials, and other litter or contamination. Topsoil shall not contain roots, stumps, and stones larger than 2 inches.

- C. Obtain topsoil from naturally well-drained areas where topsoil occurs at minimum depth of 4 inches and has similar characteristics to that found at placement site. Do not obtain topsoil from areas infected with growth of, or reproductive parts of nut grass or other noxious weeds.

2.2 TOPSOIL IN WETLAND AREAS

- A. Topsoil in wetland areas shall be scraped and stockpiled during construction activities. Final restoration of the site shall include placement of this stockpiled soil back onto the wetland areas.
- B. If additional topsoil is needed beyond what has been stockpiled, refer to Section 2.1 above for soil requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Excavate topsoil for esplanades and areas to receive grass or landscaping from areas to be further excavated. Stockpile in area approved by Engineer.
- B. Stockpile topsoil to depth not exceeding 8 feet. Cover to protect from erosion.

3.2 TOPSOIL EXCAVATION

- A. Conform to excavation and stockpiling requirements of Section 02315 - Roadway Excavation.

3.3 PLACEMENT

- A. Place no topsoil until subgrade has been approved. For areas to be seeded or sodded, scarify or plow existing material to minimum depth of 4 inches, or as indicated on Drawings. Remove vegetation and foreign inorganic material. Place 4 inches of topsoil on loosened material and roll lightly with appropriate lawn roller to consolidate topsoil.
- B. Increase depth of topsoil to 6 inches when placed over sand bedding and backfill materials specified in Section 02320 - Utility Backfill Material.
- C. For areas to receive shrubs or trees, excavate existing material and place topsoil to depth and dimensions shown on Drawings.
- D. Remove spilled topsoil from curbs, gutters, and, paved areas and dispose of

excess topsoil in accordance with requirements of Section 01576 - Waste Material Disposal.

- E. Place topsoil to promote good drainage and compact with light roller. Water topsoil after placement until saturated for minimum depth 6 inches, fill in and recompact areas of settlement.

3.4 PROTECTION

- A. Protect topsoil from wind and water erosion until planting is completed under sections 01410 - TPDES Requirements, 01570 – Storm Water Pollution Control, and under Harris County 165 – Hydro-Mulch Seeding for Erosion Control and Final Stabilization.

END OF SECTION

Section 02912

TREE, PLANT, AND HARDSCAPE PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Section includes:

1. Tree root barriers; various depths and combinations may be required.
2. Tree trunk protectors.
3. Water barriers.
4. Staking and guying materials.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for root barrier shall be on a linear foot basis for height noted.
2. Payment for tree trunk protector, water barriers and staking material shall be on a linear foot basis for height noted.
3. Refer to Section 01270-Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). When Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.3 REFERENCES

A. Standards of the following as referenced:

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).

1.4 DEFINITIONS

A. Terms:

1. Tree root barrier: Mechanical barrier and root deflector to prevent tree roots

from damaging hardscapes and landscapes.

2. Tree trunk protector: Material to protect young tree trunks from rodents, string trimmers, and lawn mowers.
3. Water barriers:
 - a. Controls run-off, preventing hardscape damage.
 - b. Prevents irrigation water from percolating under pavement.
 - c. Water corral for planting areas preventing pavement damage and saves water.
 - d. Prevents snow, ice, and saltwater run-off from polluting planting areas adjacent to roadways and parking areas.
 - e. Liner to separate golf greens and turf.
 - f. Bamboo control.

1.5 SUBMITTALS

- A. Product data: Manufacturers standard literature defining materials for use on this Project.
- B. Shop drawings:
 1. Indicate locations and extent for tree root barrier material.
 2. Indicate trees receiving tree trunk protectors.
 3. Indicate locations and extent of water barriers.
 4. Indicate trees and plants to be staked and guyed.
- C. Samples; if required by Architect:
 1. Tree root barrier: One full length panel.
 2. Tree trunk protector: One unit.
 3. Water barrier: One lineal foot of material.
 4. Staking and guying: One lineal foot.

- D. Quality control submittals; manufacturer's instructions: Complete installation instructions for each item specified; may be combined with product data.

1.6 QUALITY ASSURANCE

- A. Qualifications; manufacturer: Minimum 20 years experience in tree and plant protection and accessories.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packing and shipping: Provide materials in original unopened containers with manufacturer's labels intact and legible.

- B. Acceptance at site:

1. Damaged materials determined by visual inspection will not be accepted.
2. Remove rejected materials from Project site immediately.

- C. Storage and protection: Store materials in dry area in manufacturer's protective packaging; in original containers with labels and instruction instructions intact.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Acceptable manufacturers:

1. Products of manufacturers meeting indicated standards and specified material properties are acceptable for use, subject to approval of product list and samples.

- B. Basic Material Properties of Tree Root Barriers

Material and Thickness		Homopolymer Polyethylene
Properties	ASTM Test Method	Value Homopolymer Polyethylene
Tensile Stress Yield	D638	3800
Elongation at Break %	D638	10%
Tensile Modulus	D638	155,000
Notched Izod Impact	D256A	0.4 – 0.4
Flexural Modulus 73 PSI	0790	145,000
Hardness Shore	D2240	P66

2.2 MANUFACTURED UNITS

A. Tree root barriers:

- a) Shall be produced 12" – 48" depth.
- b) Material: 0.080" wall thickness, nominal, injection molded 50% post-consumer recycled polypropylene panels with UV inhibitors.
- c) Panel Specifics:
 1. 7/16" Wide integral molded 0.08" thickness double top edge with stiffening ribs; bottom edge attached to vertical root deflecting ribs.
 2. Integral molded 0.080" thickness by 2" deep vertical root directing ribs spaced at 6.0" O.C.
 3. Integral molded 0.080" thickness by 2" long by 3/8" wide horizontal anti-lift ground lock tabs; minimum three per panel.
- d) Preassembled joiner system for panel connection to adjacent panel.
- e) Refer to standard details for root barrier installation.

B. Tree trunk protectors:

1. Material: 0.060" thickness polyethylene with UV inhibitors, recyclable.
2. Size: 9" high by single length accommodating tree up to 4" dia.
3. Larger trees indicated for protection: Couple two or more sections together.

C. Water barriers:

1. Product standard of quality: Water Barrier WB Series.
2. Material: 0.030" 0.040" thickness High Density Polyethylene (HPDE).
3. Sizes: 24", 30", and 36" wide by 300'-0" rolls.
4. Manufacturers standard sealing tape.
5. Sealant: Silicone type recommended by water barrier manufacturer for

certain applications; applications requiring sealant indicated in manufacturers product data.

D. Staking and guying materials:

1. Material: Flat, woven polypropylene; 900 lb. break strength.
2. Size: wide by manufacturers standard roll lengths.

2.3 ACCESSORIES

A. Provide related materials for complete installation of specified materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of conditions:

1. Verify other work in other sections, in, at, and around landscaping work is complete to extent that no damage will occur to newly planted materials or, any possible construction related damage will be minimal and replacement plant material is readily available for planting at no additional cost.
2. Obtain verification, in writing, from work required in other Sections directly involving work in this Section regarding correct grades have been provided, coordination of topsoil spreading, and lawns and grasses planting.
3. The contractor shall fulfill the responsibilities below prior to beginning work. Failure to do so will require removal or replanting work in this section.
 - a. Provide written notification to Engineer of unacceptable conditions
 - b. Receive verification of written notice

3.2 PREPARATION

A. Surface protection: Use methods necessary to prevent damage to completed site work performed in other Sections. Protect access to and areas around planted materials. Restore damaged areas to original compaction, grades, and lines; repair damaged grassed areas.

3.3 INSTALLATION

- A. Tree root barriers: Install in accord with manufacturers reviewed installation instructions where indicated on reviewed shop drawings with vertical root directing ribs facing inwards towards trees or plants; connect panels together as required.

- B. Tree trunk protectors:
 - 1. Install in accord with manufacturers reviewed installation instructions where indicated on reviewed shop drawings.
 - 2. Join two or more segments together for trees over 4" dia.

- C. Water barriers:
 - 1. Install where indicated on reviewed shop drawings in accord with manufacturers reviewed installation instructions using material widths required for conditions encountered.
 - 2. Seal to hardscape surfaces with specified sealant.
 - 3. Join material lengths with manufacturers sealing tape.

- D. Staking and guying materials:
 - 1. Immediately after planting, guy and stake designated trees and large plants.
 - 2. Include tightening of guying materials to bring trees and plants to upright position.

END OF SECTION

Section 02915

TREE PLANTING

PART 1 G E N E R A L

1.1 DESCRIPTION OF WORK

- A. This section specifies the requirements and standards for planting trees using a mechanical tree spade and container grown trees.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price per tree.
 - 1. Payment for tree planting is on unit price basis for each tree planted and shall include cost of watering during maintenance period for trees not served by irrigation system.
 - 2. When shown on Drawings or directed by Engineer or RPR to remove and relocate tree affected by trench zone, work shall be paid for under one of the following bid items.
 - a. Bid item "Remove and Relocate Tree" includes moving tree with truck mounted tree spade and replanting same tree in new location. Payment is for each tree removed and relocated.
 - b. Bid item "Remove, Temporary Store and Replant Tree" includes moving tree with truck mounted tree spade and replanting tree at temporary location, (determined by Contractor) maintaining tree until construction is complete and replanting same tree back to its original location. Payment is for each tree removed, stored and replanted.
 - 3. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ANSI Z 60.1 - Nursery Stock.

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330-Submittal Procedures.
- B. Submit physical address for location of trees. Trees shall be tagged in field for transplanted trees, and at the nursery for container trees, for inspection by Engineer. Tag shall be securely attached to branch, shall be waterproof, and shall legibly bear designation of botanical and common name. Submit right of entry agreement for Engineer to access tree farm or nursery in order to inspect trees.
- C. Submit following documentation for Compost to be utilized:
 - 1. Feedstock by percentage in the final compost.
 - 2. Documentation that the compost meets federal and state health and safety regulations.
 - 3. Documentation that the composting process has met time and temperature requirements.
 - 4. Copy of producer's STA certification.
 - 5. Copy of the current TCEQ compliance statement signed by facility manager for any biosolids compost utilized.

1.5 QUALITY ASSURANCE

- A. Transplanted trees shall be planted by a contractor specializing in tree spade planted trees. The contractor shall have a minimum of 8 years experience in planting trees with truck mounted tree spades. The contractor shall have immediate access to required trees in a tree farm/field located within 40 miles of project site. Container trees shall be planted by Landscaping firm with a minimum of 3 years experience in planting container grown trees.
- B. Substitutions of specified tree species and sizes, and tree spade and container size shall not be made without written approval from Engineer. When specified planting material is not obtainable, submit proof on non-availability together with proposal for use of equivalent material. Substitutions of larger size than specified will be allowed, provided it meets requirements article 2.1 of this section, but shall be provided at no additional cost to owner.

1.6 WARRANTY

- A. Contractor shall warrant trees against defects including death, unsatisfactory growth, or loss of shape due to improper pruning, maintenance, or lack of moisture, for 2 year after completion of construction (substantial completion). Contractor shall plumb leaning trees during warranty period.

- B. Remove and replace trees found to be dead during warranty period. Remove and replace trees which have more than 40% twig and/or foliage dieback or are in doubtful condition at the end of warranty period, or if approved by Engineer, extend warranty period for such trees for a full growing season. Any trees that are required to be replaced under warranty shall be replaced at no addition cost to owner.

PART 2 P R O D U C T S AND MATERIALS

2.1 T R E E S

- A. Provide trees which are straight and symmetrical and have persistently preferred main leader. Co-dominant or dual leaders will not be allowed or accepted. Trees with a significant number of v-crotches, or trees with major branches that have v-crotches will not be allowed or accepted. The crown shall be in good overall proportion to the entire height of the tree. The minimum crown spread and height shall conform to the following standards for each tree:
 - 1. Transplant Trees:
 - 1. 3" diameter tree shall have a minimum canopy spread of 50" diameter, total tree height of 8 feet, and canopy height of 5 feet.
 - 2. 4" diameter tree shall have a minimum canopy spread of 70" diameter, overall tree height of 10 feet, and a canopy height of 6.5 feet.
 - 3. 5" diameter tree shall have a minimum canopy spread of 90" diameter, overall tree height of 12 feet, and a canopy height of 8 feet.
 - 4. 7" diameter tree shall have a minimum canopy spread of 110" diameter, overall tree height of 15 feet, and a canopy height of 10 feet.
 - 2. Container Trees:
 - 1. Tree diameter, overall tree height, and canopy height shall conform to ANSI Z 60.1 (most current publication).
- B. Tree diameter and/or container/spade size shall be as specified on the drawings. Tree diameter to be measured 6 inches above natural grade or planting media for each tree.

- C. Trees shall be healthy, vigorous, and in overall good condition. Trees shall be free of disease, insects, eggs, larvae; and free of defects such as wasp galls, knots, trunk wounds or scars, abrasions or disfigurement.
- D. Foliage shall be dark green, as dark as is typical for the given species. The tree foliage shall not be chlorotic, necrotic, or dying back.

2.2 SOIL CONDITIONER OR ROOT STIMULATOR

- A. Root stimulator shall contain at a minimum the following ingredients:
Ectomycorrhizal
Fungi, VA Mycorrhizal(VAM) Fungi, Rhizosphere Bacillus spp., Kelp Meal, Humic Acid, and Soluble Yucca.

2.3 SAND BACKFILL

- A. Sand backfill shall be a fine sandy loam, typical of the soil at the project site, or fine bank sand. The back fill shall be free of noxious weeds, grasses, sticks, roots or stone and shall be consistent in texture.

2.4 COMPOST

- A. Compost shall have been produced by aerobic (biological) decomposition of organic matter. Compost feedstock may include, but is not limited to, leaves and yard trimmings, biosolids, food scraps, food-processing residuals, manure or other agricultural residuals, forest residues, bark, and paper. Compost and wood chips shall not contain any visible refuse, other physical contaminants, or any substance considered harmful to plant growth. Compost shall not contain materials that have been treated with chemical preservatives as a compost feedstock or as a wood chip. Compost shall not contain mixed municipal solid waste compost. Compost shall meet all applicable 40 CFR 503 standards for Class A biosolids and TCEQ health and safety regulations as defined in the TAC, Chapter 332, including the time and temperature standards in Subchapter B, Part 23. Meet the requirements of the United States Composting Council (USCC) Seal of Testing Assurance (STA) program.

2.5 MULCH

- A. Mulch shall be shredded hardwood, free of noxious weed seeds.

2.6 WATER

- A. Water shall be potable from municipal water supplies.

2.7 SOURCE QUALITY CONTROL

- A. Notify Engineer, prior to delivery and planting, with location where trees that have been tagged for planting may be inspected. Trees will be inspected for compliance with this specification.

PART 3 EXECUTION

3.1 EQUIPMENT (Applies to Transplant Trees)

- A. Tree spade shall be in good condition with minimum tolerances between digging blades. All blades shall be true to their designed spade free of bends and deformities. The tree spade shall be mounted on suitable, stable machines capable of supporting the weight of all dug materials and heavy enough to force all blades into the soil to full depth. Holes to receive machine transplanted trees shall be dug with machines of like size and manufacture to that which is used to dig the intended tree.
- B. Trees shall be transplanted with minimum tree spade sizes for maximum tree diameter per the following standards:
 - 1. Maximum tree diameter for 50" tree spade shall be 3"
 - 2. Maximum tree diameter for 60" tree spade shall be 4"
 - 3. Maximum tree diameter for 80" tree spade shall be 5"
 - 4. Maximum tree diameter for 90" tree spade shall be 7"
 - 5. Maximum tree diameter for 120" tree spade shall be 9"

3.2 PREPARATION FOR PLANTING

- A. Schedule work so that planting can proceed as rapidly as the planting site becomes available. Plant trees after final grades are established and prior to planting of turf, unless otherwise approved by Engineer in writing. If planting of trees occurs after seeding work, protect turf areas and promptly repair damage to turf resulting from tree planting operations.
- B. Layout individual trees at locations shown on Drawings. In case of conflicts, notify Engineer before proceeding with work. Trees shall be laid out and approved by Engineer prior to planting.
- C. The contractor shall be responsible for locating and confirming underground utilities.
- D. Trees shall be pruned, at the farm, to remove dead, diseased, dying, or broken branches that will be detrimental to the future shape or structure of the tree. Old

pruning stubs should also be removed. All pruning cuts should be made sufficiently close to the branch collar, so as not to leave a protruding stub, without cutting into the branch collar. Each cut shall be made with the appropriately sized pruning shear, which should have properly matched, sharpened blades. Pruning cuts shall not be painted or otherwise treated.

- E. Trees are subject to inspection at the tree farm or location of collection. When directed, provide and use serialized locking tags on trees.
- F. Contractor shall notify Engineer least 48 hours before delivering trees to worksite. Coordinate with Authority for inspection and approval of materials upon delivery. Remove rejected trees from the worksite and replace as directed.
- G. Container grown trees shall be thoroughly watered prior to leaving tree farm or nursery.

3.3 COLLECTING, TRANSPORTING AND PLANTING

Transplant Trees

- A. Tree shall be centered in tree spade at digging.
- B. No damage to branches or trunk shall be allowed while backing onto tree at tree farm, digging tree, or pulling away from tree after planting. Damage to tree trunk caused by the digging or planting of the tree, will be grounds for non-acceptance of tree under this specification.
- C. Roots protruding from the digging blades shall be pruned flush with the root ball prior to planting.
- D. Contractor shall ensure tree is tied down so that the total height of the tree spade and tree do not exceed legal height limits.
- E. Tree shall be covered with an open-weave fabric tarp to minimize wind damage and desiccation of leaves during transportation from collection site to planting site.
- F. Each tree shall be planted in its final planting site within 4 hours of being dug from the collection site.
- G. Tree shall be planted plumb and the root ball shall be set 2-3 inches above the finished grade.
- H. No staking or guying of the tree should be installed.
- I. Voids between existing grade and tree root ball shall be backfilled with sand backfill. The sand backfill should be thoroughly watered into the voids, so that no

air pockets remain.

- J. A water holding basin shall be constructed around each tree. The basin should be constructed with the sand backfill and shall be constructed directly over the void between the existing grade and root ball, 6-8" in height, and 8-10" in width. The top of the root ball shall not be covered with sand backfilled or any other type of soil.
- K. Prior to mulching, each tree shall be thoroughly watered 2 separate times. Each time the watering basin should be filled with water and the water allowed to soak the tree and force sand backfill into all voids. After the second watering basin should be rebuilt to its original shape.
- L. Each tree shall be thoroughly soaked with root stimulator, per label instructions.
- M. Mulching shall be completed within 24 hours of planting. A 4" deep layer of mulch shall be applied to the entire water holding basin and top of root ball. No mulch shall be applied directly against the trunk of the tree.
- N. Control dust caused by planting operations. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

Container Trees

- A. Excavate planting pit to a depth equal to planting media height in container, or 1-2" shallower. Do not over excavate, to ensure planted root ball rest on undisturbed sound soil. Planting pit shall have a diameter that is at least 2 feet wider than diameter of root ball.
- B. When conditions detrimental to plant growth are encountered, such as unsatisfactory soil, obstructions, or adverse drainage conditions, notify Engineer.
- C. Edges of planting pit shall be scarified with gouges a minimum of 1" deep and 1" wide spaced no wider than 8" on center.
- D. Trees shall be planted within 24 hours of excavating planting pits to minimize soil desiccation.
- E. Trees shall be handled by container during transportation and planting. Trees shall not be handled by grasping trunk only.
- F. Trees shall be covered with open weave tarp in transportation from nursery to planting site, to minimize tree and leaf desiccation.
- G. Deliver trees after preparations for planting have been completed and plant immediately. If planting does not occur within 6 hours of delivery, set trees in shade, protect from weather and mechanical damage, and keep root balls moist by

covering with mulch, compost, burlap, or other acceptable means of retaining moisture. Water trees as needed to avoid root ball desiccation.

- H. Each tree shall be removed from container without cracking or disturbing root ball. The circumference of the root ball shall be scored with sharp utility knife ½" deep, from top to bottom of ball, at 8" intervals to cut any circling roots.
- I. Set root ball in planting pit, on undisturbed soil, in center of pit and plumb plant. Top of root ball shall be at same elevation of finished grade or 1-2" above finished grade.
- J. Backfill planting pit around root ball in lifts, each lift shall be 1/3 the depth of the root ball. Pit shall be thoroughly watered after each lift to remove air pockets. Backfill shall consist of the following materials:
 - 1. Soil excavated from planting pit: 75 percent
 - 2. Compost: 15 percent
 - 3. Peat moss: 10 percent
- K. Construct a plant basin at least 6 inches deep with an inside diameter equal to the planting pit diameter and with a level top around the plant unless otherwise indicated on plans. Use excavated soil from the planting pit, amended backfill material, or approved material for the basin.
- O. Mulching shall be completed within 24 hours of planting. A 4" deep layer of mulch shall be applied to entire water holding basin and top of root ball. No mulch shall be applied directly against the trunk of the tree.
- P. Each tree shall be guyed and staked immediately after planting. Each tree shall have a minimum of 2 post; more may be required depending on soil structure. Provide adequate number of post to ensure tree stability during establishment. Tree shall be secured by plastic tree chain, do not use wire with plastic or rubber guards.
- Q. Control dust caused by planting operations. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

3.4 FIELD QUALITY CONTROL

- A. Engineer may reject unsatisfactory or defective material at anytime during progress of work. Contractor shall remove rejected trees immediately from site and replace with specified materials. Plant material not installed in accordance with these specifications will be rejected.

- B. An inspection to determine final acceptance will be conducted by Engineer at the end of the 24 month maintenance period. Additional inspections will be conducted for extended warranty periods provided for in paragraph 1.06B.

3.5 MAINTENANCE PERIOD

- A. Contractor shall maintain trees during planting operations and for a period of 24 months after completion of construction (substantial completion).
- B. Contractor shall water trees during maintenance period to ensure tree establishment. Trees served with bubblers or drip irrigation will not require manual watering.
- C. Contractor shall apply a minimum of 25 gallons of water to each tree weekly, or more if required to maintain healthy vigorous growth. No watering shall be required during weeks when the planting site receives at least 1" of rainfall. Rainfall to be measured at planting site.

3.6 CLEANUP AND PROTECTION

- A. During planting work, keep pavement clean and work area in an orderly condition.
- B. No open planting holes shall be left at planting site without immediate supervision by planting personnel. Use plywood, or other suitable material, to cover open hole when not under immediate supervision.
- C. Protect planting work and material from damage due to planting operations. Maintain protection during installation and maintenance period. Treat, repair, or replace damaged planting work as directed by Engineer.
- D. Dispose of excess soil and waste in accordance with requirements of Section 01576-Waste Material Disposal. On-site burning of combustible materials shall not be permitted.

END OF SECTION

Section 02921

HYDRO MULCH SEEDING

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Seeding, fertilizing, mulching, and maintenance of areas indicated on Drawings.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. Payment for hydro mulch seeding is on an acre basis, within limits of construction if shown on the drawings.
- 2. No payment will be made for hydro mulch seeding under this Section if limits of constructions are not shown on the drawings or water line size is less than 24-inch. Include payment in Section 01740 – Site Restoration.
- 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification from supplier that each type of seed conforms to these specifications and requirements of Texas Seed Law. Certification shall accompany seed delivery.
- C. Submit certificate stating that fertilizer complies with these specifications and requirements of Texas Fertilizer Law.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Topsoil: Conform to material requirements of Section 02911 - Topsoil.

- B. Seed: Conform to U.S. Department of Agriculture rules and regulations of Federal Seed Act and Texas Seed Law. Seed shall be certified 90 percent pure and furnish 80 percent germination and meet following requirements:

1. Rye: Fresh, clean, Italian rye grass seed (*loium multi-florum*), mixed in labeled proportions. As tested, minimum percentages of impurities and germination must be labeled. Deliver in original unopened containers.
2. Bermuda: Extra-fancy, treated, lawn type common bermuda (*Cynodon dactylon*). Deliver in original, unopened container showing weight, analysis, name of vendor, and germination test results.
3. Wet, moldy, or otherwise damaged seed will not be accepted.
4. Seed requirements, application rates, and planting dates are:

TYPE	APPLICATION RATE POUNDS/ACRE	PLANTING DATE
Hulled Common Bermuda Grass 98/88 Unhulled Common Bermuda Grass 98/88	40 40	Jan 1 to Mar 31
Hulled Common Bermuda Grass 98/88	40	Apr 1 to Sep 30
Hulled Common Bermuda Grass 98/88 Unhulled Common Bermuda Grass 98/88 Annual Rye Grass (Gulf)	40 40 30	Oct 1 to Dec 31

- C. Seed for Wetland Areas: Conform to U.S. Department of Agriculture rules and regulations of Federal Seed Act and Texas Seed Law. As tested, minimum percentages of impurities and germination must be labeled. Deliver in original unopened containers. Seed shall be certified 90 percent pure and furnish 80 percent germination and meet following requirements:

1. Rye: Fresh, clean, Italian rye grass seed (*loium multi-florum*), mixed in labeled proportions.
2. Millet: Brown Top or Foxtail.
3. Legume

4. Grain
5. Pensacola Bahia Grass
6. Wet, moldy, or otherwise damaged seed will not be accepted.
7. Seed requirements, application rates, and planting dates are:

TYPE	APPLICATION RATE POUNDS/ACRE	PLANTING DATE
Rye and Millet	25 25	Oct 1 to Mar 31
Legume or Grain and Pensacola Bahia Grass	20 or 20 20	Apr 1 to Sept 30

- D. Fertilizer: Dry and free flowing, inorganic, water soluble commercial fertilizer, which is uniform in composition. Deliver in unopened containers which bear manufacturers guaranteed analysis. Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of following elements:

1. Nitrogen: 10 Percent
2. Phosphoric Acid: 20 Percent
3. Potash: 10 Percent

- E. Mulch:

1. Virgin wood cellulose fibers from whole wood chips having minimum of 20 percent fibers 0.42 inches in length and 0.01 inches in diameter.
2. Cellulose fibers manufactured from recycled newspaper and meeting same fiber content and size as for cellulose fibers from wood chips.
3. Dye mulch green for coverage verification purposes.

- F. Soil Stabilizer: "Terra Tack 1" or approved equal.

- G. Weed control agent: Pre-emergent herbicide for grass areas, such as "Benefin," or approved equal.

PART 3 EXECUTION

3.1 PREPARATION

- A. Place and compact topsoil in accordance with requirements of Section 02911 - Topsoil.
- B. Dispose of Objectionable and Waste Materials in accordance with Section 01576 - Waste Material Disposal.

3.2 APPLICATION

- A. Seed: Apply uniformly at rates given in Paragraph 2.1 B for type of seed and planting date.
- B. Fertilizer: Apply uniformly at rate of 500 pounds per acre.
- C. Mulch: Apply uniformly at rate of 50 pounds per 1000 square feet.
- D. Soil Stabilizer: Apply uniformly at rate of 40 pounds per acre.
- E. Weed Control Agent: Apply at manufacturer's recommended rate prior to hydro mulching.
- F. Sod: Lay single row of sod along perimeter where top soil and pavement intersect. Apply in conformance to Section 02922 - Sodding.
- G. Suspend operations under conditions of drought, excessive moisture, high winds, or extreme or prolonged cold. Obtain Engineer approval before resuming operations.
- H. Contractor shall confine hydro-mulching to areas defined on plans and avoid overspray onto paved areas.

3.3 MAINTENANCE

- A. Maintain grassed areas minimum of 90 days, or as required to establish an acceptable lawn. For areas seeded in fall, continue maintenance following spring until acceptable lawn is established.
- B. Maintain grassed areas by watering, fertilizing, weeding, and trimming.
- C. Repair areas damaged by erosion by regrading, rolling and replanting.
- D. Reseed small, sparse grass areas. When sparse areas exceed 20 percent of planted area, reseed by hydro mulch.

- E. Mow grass when height reaches 3 1/2 inches or greater on average before final acceptance. Mow to height of 2 1/2 inches.

END OF SECTION

Section 02922

SODDING

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Restoration of existing lawn areas disturbed by construction shall be by installation of new sod.
- B. Planting of sod within areas designated on Drawings for purpose of surface stabilization, channel stabilization or vegetation buffer strips.
- C. Sod is defined as blocks, squares, strips of turfgrass, and adhering soil used for vegetative planting. To be placed edge to edge for complete coverage.
- D. Lawn is defined as ground covered with fine textured grass kept neatly mowed.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for sodding is on square yard basis.
 - 2. For water line less than 24-inches, no separate payment will be made for sodding. Include payment in Section 01740 - Site Restoration.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

1.4 QUALITY ASSURANCE

- A. Sod only when weather and soil conditions are deemed by Engineer to be suitable for proper placement.
- B. Water and fertilize new sod.

- C. Guarantee sod to be growing 30 days after substantial completion.
- D. Maintenance Period:
 - 1. Begin maintenance immediately after each section of grass sod is installed and continue for 30 day period from date of substantial completion.
 - 2. Resod unacceptable areas.
 - 3. Water, fertilize, control disease and insect pests, mow, edge, replace unacceptable materials, and perform other procedures consistent with good horticultural practice to ensure normal, vigorous and healthy growth. Install disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.
- E. Notify Engineer 10 days before end of maintenance period for inspection.

PART 2 P R O D U C T S

2.1 SOD

- A. Species: Bermuda (*Cynodon Dactylon*), Buffalo (*Buchloe Dactyloides*), or St. Augustine (*Stenotaphrum Secundatum*) Gulf Coast variety to match existing sod.
- B. Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.
- C. Size: 12 inch wide strips, uniformly 2 inches thick with clean-cut edges.
- D. Sod is to be supplied and maintained in healthy condition as evidenced by grass being normal green color.

2.2 FERTILIZER

- A. Available nutrient percentage by weight: 12 percent nitrogen, 4 percent phosphoric acid, and 8 percent potash; or 15 percent nitrogen, 5 percent phosphoric acid, and 10 percent potash.

2.3 WEED AND INSECT TREATMENT

- A. Provide acceptable treatment to protect sod from weed and insect infestation. Submit treatment method to Engineer for approval. Install insect and disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

2.4 WATER

- A. Potable, available on-site through Contractor's water trucks. Contractor may use hydrants when water use is measured through Contractor's meter. Do not use private resident's water.

2.5 BANK SAND

- A. Free of clay lumps, roots, grass, salt or other foreign material.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that soil placement and compaction have been satisfactorily completed. Verify that soil is within allowable range of moisture content.
- B. Top soil shall be free of weeds and foreign material immediately before sodding.
- C. Do not start work until conditions are satisfactory. Do not start work during inclement or impending inclement weather.
- D. Rake areas to be sodded smooth, free from unsightly variations, bumps, ridges or depressions.
- E. Spread 2 inch layer of bank sand over areas to be sodded prior to planting of sod.
- F. Apply fertilizer at rate of 25 pounds per 1000 square feet. Apply after raking soil surface and not more than 48 hours prior to laying sod. Mix thoroughly into upper 2 inches of soil. Lightly water to aid in dissipation of fertilizer.

3.2 APPLICATION

- A. Full Sodding: Lay sod with closely fitted joints leaving no voids and with ends of sod strips staggered. Lay sod within 24 hours of harvesting.
- B. On slopes 2:1 and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
- C. Prior to placing sod, on slopes 3:1 or where indicated, place Hold/Gro or Roll Lite or equal over topsoil. Securely anchor in place with posts sunk firmly into ground at maximum 16 feet on center along pitch of slope and equal to width of wire mesh horizontally across slopes.
- D. After sod is laid, irrigate thoroughly to secure 6-inch minimum penetration into soil

below sod.

- E. Tamp and roll sod with approved equipment to eliminate minor irregularities and to form close contact with soil bed immediately after planting and watering. Submit type of tamping and rolling equipment to be used to Engineer for approval, prior to construction.

3.3 MAINTENANCE

A. Watering:

1. Water lawn areas once a day with minimum 1/2 inch water for first 3 weeks after area is sodded.
2. After 3 week period, water twice a week with 3/4 inch of water each time unless comparable amount has been provided by rain.
3. Make weekly inspections to determine moisture content of soil unless soil is in frozen condition.
4. Water in afternoon or at night to enable soil to absorb maximum amount of water with minimum evaporation.

B. Mowing:

1. Mow sod at intervals which will keep grass height from exceeding 3 1/2 inches.
2. Set mower blades at 2 1/2 inches.
3. Do not remove more than one-half of grass leaf surface.
4. Mow sodded areas requiring mowing within 1 month after installation with light-weight rotary type mower. Mow sod only when dry and not in saturated or soft condition.
5. Remove grass clippings during or immediately after mowing.

C. Fertilizer and Pest Control:

1. Evenly spread fertilizer composite at rate of 40 pounds per 5000 square feet or as recommended by manufacturer. Do not place fertilizer until 2 weeks after placement of sod.
2. Restore bare or thin areas by topdressing with mix of 50 percent sharp sand and 50 percent sphagnum peat moss.
3. Apply mixture 1/4 to 1/2 inch thick.

- 4. Treat areas of heavy weed and insect infestation as recommended by treatment manufacturer.
 - D. Restrict all traffic from sodded areas until sod is established or for minimum 10 days during growing season. Use wood lath and plastic tape to cordon sodded areas. Maintain tape and lath throughout for minimum 30 days during growing season.
- 3.4 CLEANUP
- A. During course of planting, remove excess and waste materials; keep lawn areas clean and take precautions to avoid damage to existing structures, plants, grass, and streets.
 - B. Remove barriers, signs, and other Contractor material and equipment from project site at termination of establishment period.
 - C. Dispose of unused materials and rubbish in accordance with Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02951

PAVEMENT REPAIR AND RESTORATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Repairing and replacing streets, highways, and other pavements as required per street cut ordinance that have been cut, broken, or damaged due to utility excavation.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for pavement repair and replacement for utility projects is on a square yard basis and includes surface and base materials as required per street cut ordinance.
 - 2. Measurement for utility projects: Match actual pavement replaced but no greater than maximum pavement replacement limits in accordance with the street cut ordinance or otherwise shown on drawings.
 - 3. Refer to Section 01270 - Measurement and Payment for other unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this section is included in total Stipulated Price.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Subgrade:
 - 1. Provide backfill material as required by applicable excavation and fill sections (Sections 02315 through 02322) and Section 02330 - Embankment.
 - 2. Provide material for stabilization as required by applicable portions of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, Section 02338 - Portland Cement Stabilized Subgrade, and Section 02321 – Cement Stabilized Sand.

- B. Base: Provide base material as required by applicable portions of Section 02711 - Hot Mix Asphaltic Base Course, Section 02712 - Cement Stabilized Base Course, and Section 02713 - Crushed Concrete Base Course.
- C. Pavement: Provide paving materials as required by applicable portions of Section 02741 - Asphaltic Concrete Pavement, Section 02751- Concrete Paving, Section 02754 - Concrete Driveways, and Section 02771 - Curb, Curb and Gutter, and Headers, and Section 02775 - Concrete Sidewalks.

PART 3 EXECUTION

3.1 PREPARATION

- A. Notify Authority prior to commencement of excavation in pavement for which an Excavation in Public Way permits has been obtained. Follow directions contained in the permit.
- B. Conform to requirement of Section 02221 - Removing Existing Pavements and Structures, for removals.
- C. Saw cut pavement 18 inches wider than width of trench needed to install utilities unless otherwise indicated on Drawings.
- D. When new Work is adjacent to existing concrete and existing joint is a construction joint (ex., deformed metal strip joints, tooled joints, partially saw cut joints with sealant, etc.), then unless otherwise directed by the authority, provide full-depth saw cut 2-inch maximum away from pavement construction joints. Saw cut distance from joint shall be minimum necessary for a clean straight edge, and if the joint is at the crown the saw cut shall be as close to the crown as possible. Saw cut shall provide straight, smooth joint surface without chipping, spalling, or cracks.
- E. Protect edges of existing pavement to remain from damage during removals, utility placement, backfill, and paving operations. For concrete pavement, protect undisturbed subgrade that is to remain to support replacement slab.
- F. Dowel in existing pavement where no reinforcement is found or is broken due to construction activities. Unless otherwise directed by Engineer, provide No. 6 bars 24 inches long, drilled and embedded 8 inches into center of existing slab with 'PO-ROC' epoxy grout or approved equal. Space dowels to match new pavement reinforcement spacing.
- G. Provide transitional paving and earthwork as required to tie proposed pavement to existing pavement when unable to dowel new pavement into existing

pavement.

- H. If existing pavement thickness is less than 7-inches, then dowels will be deleted and the non doweled expansion joint detail will be used instead, unless directed otherwise by the Authority.
- I. When new Work is adjacent to existing concrete pavement and existing joint is an expansion joint, then place joints at same location as existing joints in adjacent pavement. Dowels at existing expansion joints shall be saw cut to eliminate possible damage to adjacent pavement that is scheduled to remain. The cost for this saw cut is incidental to the pavement removal and disposal pay item(s).
- J. If the Contractor's work results in voids under adjacent lanes of pavement then, unless otherwise directed by the authority, the Contractor shall remove and replace the damaged pavement in accordance with Section 02951 and the Street Cut Ordinance, at no additional cost to the Authority.

3.2 INSTALLATION

- A. Parking Areas, Service Drives, Driveways, and Sidewalks: Replace with material equal to or better than existing or as indicated on Drawings. Conform to applicable requirements of sections referenced in Paragraph 2.01, Materials.
- B. Street Pavements and Curbs, Curbs and Gutters: Replace subgrade, base, and surface course with like materials or as indicated on Drawings. Curbs and gutters shall match existing. Conform to requirements of sections referenced in Paragraph 2.01, Materials.
- C. For concrete pavement, install size and length of reinforcing steel and pavement thickness indicated on Drawings. Place types and spacing of joints to match existing or as indicated on Drawings.
- D. Where existing pavement consists of concrete pavement with asphaltic surfacing, resurface with minimum 2 inch depth asphaltic pavement.
- E. Repair state highway and county crossings in accordance with TxDOT standard details and permit requirements and/or County standard details, specifications, and requirements as appropriate and within 1 week after utility work is installed.

3.3 WASTE MATERIAL DISPOSAL

- A. Dispose of waste material in accordance with requirements of Section 01576 - Waste Material Disposal.

3.4 PROTECTION

- A. Protect and maintain pavement in good condition until completion of Work.
- B. Provide traffic barrels and/or traffic control barriers as per Section 01555 – Traffic Control and Regulation and Harris County 670 Barricades. Barricades are to be removed after pavement has reached 75% of 28 day strength. Placement and maintenance of barricades is incidental to cost of pavement repaired under this Section.
- C. Replace pavement damaged by Contractor's operations at no cost to Authority.

END OF SECTION

Section 03100
CONCRETE FORMWORK

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Design, construction, erection and removal of structural concrete formwork.

1.02 UNIT PRICES

- A. No separate payment will be made for concrete formwork under this Section. Include payment in unit price for structural concrete.
- B. Refer to Section 01025 - Measurement and Payment for unit price procedures.

1.03 REFERENCE STANDARDS

- A. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
- B. ACI 347 - Recommended Practice for Concrete Formwork.
- C. U.S. Product Standard PS 1 Construction and Industrial Plywood.
- D. U.S. Product Standard PS 20 American Softwood Lumber Standard.

1.04 SUBMITTALS

- A. Conform to Section 01300 - Submittals.
- B. Shop Drawings: Show location, member size and loading of shoring. When reshoring is permitted, submit plans showing locations and member size of reshoring.
- C. Product Data and Samples:
 - 1. Corrugated Fiberboard Carton Forms: Submit certification of compliance with design criteria, description of forms, and one-foot-long sample.
 - 2. Form-coating Materials: Submit trade or brand names of manufacturers and complete description of products.
 - 3. Form ties and related accessories, including taper tie plugs, if taper ties are used. Form gaskets.
 - 4. Detailed Layout for Slip-forming: Submit detailed layout of proposed slipforming, including description of equipment, rate of progress, and other data to show suitability of method. Show provisions for ensuring attainment of required concrete surface finish.

PART 2 P R O D U C T S

2.01 MATERIAL

- A. Smooth Forms: New plywood, metal, plastic, tempered concrete-form hardboard, dressed lumber faced with plywood or fiberboard lining, or metal-framed plywood-

faced panel material, to provide continuous, straight, smooth surfaces. Form material shall be free of raised grain, torn surfaces, worn edges, patches, dents or other defects. Furnish material in largest practical sizes to minimize number of joints and, when indicated on Drawings, conform to joint system indicated. Form material shall have sufficient strength and thickness to withstand pressure of newly placed concrete without bow or deflection.

- B. Rough Forms: Plywood, metal, dressed or undressed lumber free of knots, splits or other defects, or other material acceptable to Engineer of sufficient strength and thickness to withstand pressure of newly placed concrete without bow or deflection.
- C. Plywood: Conform to PS 1, Class 1.
- D. Lumber: Conform to PS 20.
- E. Edge Forms and Intermediate Screed Strips: Type and strength compatible with the screed equipment and methods used.
- F. Plastic Forms: One-piece forms for domes, beams and pan joists. Single lengths for columns not exceeding height of 7 feet 6 inches. For columns over 7 feet 6 inches, use 7-foot 6-inch sections and filler sections as needed. To facilitate removal of pan joist forms, taper sides one inch per foot.
- G. Metal Pan Joist Forms: Removable type; fabricated of minimum 14-gauge steel; one piece between end closures. Adjustable forms not allowed. Taper sides one inch per foot to facilitate removal.
- H. Earth Cuts for Forms:
 - 1. Use earth cuts for forming unexposed sides of grade beams cast monolithically with slabs on grade.
 - 2. Where sides of excavations are stable enough to prevent caving or sloughing, following surfaces may be cast against neat-cut excavations:
 - a. Sides of footings.
 - b. Inside face of perimeter grade beams not monolithic with slab on grade. When inside face is cast against earth, increase beam width indicated on Drawings by one inch.
 - c. Both faces of interior grade beams not monolithic with slab on grade. When grade beam is cast against earth, increase beam width indicated on Drawings by 2 inches.
- I. Corrugated Fiberboard Carton Forms:
 - 1. Corrugated fiberboard carton forms, when called for, are intended to form a void space beneath pile-supported and pier-supported slabs and other structural elements as shown.
 - 2. Provide products of a reputable manufacturer regularly engaged in commercial production of double-faced corrugated fiberboard carton forms, constructed of waterproof paper and laminated with waterproof adhesive.

3. Fiberboard forms: Capable of supporting required dead load plus construction loads, and designed to lose their strength upon prolonged contact with moisture and soil bacteria.
 4. Seal cuts and ends of each form section by dipping in waterproof wax, unless liners and flutes are completely impregnated with waterproofing.
 5. Size forms as indicated on Drawings. Assemble as recommended by manufacturer, either with steel banding at 4 feet 0 inches maximum on centers, or, where liners and flutes are impregnated with waterproofing, with adequate stapling.
- J. Circular Forms:
1. Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation. Provide manufacturer's seamless units to minimize spiral gaps and seams.
 2. Fiberglass or steel forms may be used for round-section members.
- K. Shores: Wood or adjustable metal, with bearing plates; with double wedges at lower end.
- L. Form Ties:
1. Use commercially-manufactured ties, hangers and other accessories for embedding in concrete. Do not use wire not commercially fabricated for use as a form accessory.
 2. Fabricate ties so ends or end fasteners can be removed without causing spalling of concrete faces. Depth from formed concrete face to the embedded portion: At least 1 inch, or twice the minimum dimension of tie, whichever is greater.
 3. Provide waterstop feature for form ties used on liquid-containing structures and on concrete walls which will have earth backfill on one side.
 4. Removable ties: Taper ties may be used when approved by the Engineer. In the hole left by the removal of the taper tie, insert a preformed neoprene or polyurethane plug sized to seat at the center of the wall.
- M. Form Coating: Commercial formulation of form oil or form-release agent having proven satisfactory performance. Coating shall not bond with, stain or otherwise adversely affect concrete surfaces, or impair their subsequent treatment, including application of bonding agents, curing compounds, paint, protective liners and membrane waterproofing.
- N. Coating for Plastic Forms: Alkali-resistant gel-coat.
- O. Chamfer Strips: Unless otherwise indicated on Drawings, provide 3/4-inch chamfer strips in corners of forms to produce beveled edges where required by Part 3, Execution.
- P. Form Gaskets: Polyethylene rod, closed cell, one-inch diameter.

2.02 DESIGN OF FORMWORK

- A. Conform to ACI 117, ACI 347 and Authority building codes, unless more restrictive requirements are specified or shown on Drawings. Contractor shall design and engineer concrete formwork, including shoring and bracing. Design formwork for applicable gravity loads, lateral pressure, wind loads and allowable stresses. Camber formwork to compensate for anticipated deflection during placement of concrete when required to maintain specified tolerances. Design formwork to be readily removed without impact, shock or damage to concrete surfaces and adjacent materials.
- B. Slip Forming: Permitted on written approval of Engineer. Contractor shall demonstrate suitability of method proposed.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Formwork Construction
 - 1. Construct and maintain formwork so that it will maintain correct sizes of members, shape, alignment, elevation and position during concrete placement and until concrete has gained sufficient strength. Provide for required openings, offsets, sinkages, keyways, recesses, moldings, anchorages and inserts.
 - 2. Construct forms for easy removal without damage to concrete surfaces.
 - 3. Make formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins. Provide gaskets for wall forms to prevent concrete paste leakage at their base.
 - 4. Place chamfer strips in forms to bevel edges and corners permanently exposed to view, except top edges of walls, and slabs which are indicated on Drawings to be tooled. Do not bevel edges of formed joints and interior corners unless indicated on Drawings. Form beveled edges for vertical and horizontal corners of equipment bases. Unless otherwise indicated on Drawings, make bevels 3/4 inch wide.
 - 5. Provide temporary openings at bases of column and wall forms and other points as required for observation and cleaning immediately before concrete is placed.
 - 6. Where runways are required for moving equipment, support runways directly on the formwork or structural members. Do not allow runways or supports to rest on reinforcing steel.
 - 7. Use smooth forms on formed concrete surfaces required to have smooth form finish or rubbed finish as specified in Section 03350 - Concrete Finishing.
 - 8. Rough forms may be used on formed concrete surfaces indicated to have rough form finish as specified in Section 03350 - Concrete Finishing.

- B. Forms for Surfaces Requiring Smooth Form Finish:
 - 1. Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Uniformly space form ties and align in horizontal and vertical rows. Install taper ties, if used, with the large end on the wet face of the wall.
 - 2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back up joints with extra studs or girts to maintain true, square intersections.
 - 3. Form molding shapes, recesses and projections with smooth-finish materials and install in forms with sealed joints to prevent displacement.
 - 4. Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines.
 - 5. Provide exterior exposed edges with 3/4-inch chamfer or 3/4-inch radius.
 - 6. Arrange facing material in orderly and symmetrical fashion. Keep number of joints to practical minimum. Support facing material adequately to prevent deflection in excess of allowable tolerances.
 - 7. For flush surfaces exposed to view in completed structure, overlap previously-placed hardened concrete with form sheathing by approximately 1 inch. Hold forms against hardened concrete to maintain true surfaces, preventing offsets or loss of mortar.
- C. Forms for Surfaces Requiring Rubbed Finish: Provide forms as specified in Paragraph 3.1B, Smooth Form Finish. Use smooth plywood or fiberboard linings or forms, in as large sheets as practicable, and with smooth, even edges and close joints.
- D. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure supports for types of screeds required.
- E. Circular Forms: Set forms in one piece for full height of member.
- F. Surfaces to Receive Membrane Waterproofing: Coordinate surface finish, anchors, reglets and similar requirements with membrane waterproofing applicator.
- G. Fireproofing Steel Member: Construct forms to provide not less than the concrete thickness necessary, measured from face of steel member, to provide the required fire rating. Forms for concealed surfaces may be unlined.
- H. Tolerances:
 - 1. Unless noted otherwise on Drawings, construct formwork so concrete surfaces will conform to tolerance limits listed in Tables 03100A and 03100B at end of this Section.
 - 2. Establish sufficient control points and bench marks as references for tolerance checks. Maintain these references in undisturbed condition until final completion and acceptance of the Work.
- I. Adjustment of Formwork:

1. Use wedges or jacks to provide positive adjustment of shores and struts. After final inspection and before concrete placement, fasten in position wedges used for final adjustment of forms.
2. Brace forms securely against lateral deflections. Prepare to compensate for settling during concrete placement.
3. For wall openings, construct wood forms that facilitate necessary loosening to counteract swelling of forms.

J. Corrugated Fiberboard Carton Forms:

1. Place on smooth firm bed of suitable material to prevent vertical displacement; set tight to prevent horizontal displacement. Exercise care to avoid buckling of forms. Install in accordance with manufacturer's directions and recommendations.
2. Fit carton forms tightly around piles and piers; completely fill the space between subgrade and concrete placement with carton forms to form a void space.
3. Protect carton forms from moisture and maintain in a dry condition until concrete is placed on them. If they become wet before placement of concrete, allow them to dry and carefully inspect for strength before concrete is placed.
4. Before concrete placement, replace damaged or deteriorated forms which are incapable of supporting concrete dead load plus construction live loads.

3.02 PREPARATION OF FORM SURFACES

- A. Clean surfaces of forms and embedded materials before placing concrete. Remove accumulated mortar, grout, rust and other foreign matter.
- B. Coat forms for exposed or painted concrete surfaces with form oil or form-release agent before placing reinforcement. Cover form surfaces with coating material in accordance with manufacturer's printed instructions. Do not allow excess coating material to accumulate in forms or to contact hardened concrete against which fresh concrete will be placed. Remove coating material from reinforcement before placing concrete.
- C. Forms for unexposed surfaces, other than retained-in-place metal forms, may be wet with water immediately before concrete placement in lieu of coating. When possibility of freezing temperatures exists, however, the use of coating is mandatory.

3.03 REMOVAL OF FORMS

- A. Time Limits:
 1. When repair of surface defects or finishing is required before concrete is aged, forms on vertical surfaces may be removed as soon as concrete has hardened sufficiently to resist damage from removal operations.
 2. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

Leave formwork for water-retaining structures in place for at least 2 days. Formwork for non-water-retaining columns, walls, sides of beams and other formwork components not supporting weight of concrete may be removed after 12 hours, provided concrete has hardened sufficiently to resist damage from removal operations, and provided removal of forms will not disturb members supporting weight of concrete.

3. Forms and shoring supporting weight of concrete or construction loads: Leave in place until concrete has reached minimum strength specified for removal of forms and shoring. Do not remove such forms in less than 4 days.
- B. Circular Paper or Spiral Tube Forms: Follow manufacturer's directions for form removal. Take necessary precautions to prevent damage to concrete surface. When removal is done before completion of curing time, replace form, tie in place and seal to retard escape of moisture.
- C. Removal Strength:
1. Control Tests: Suitable strength-control tests will be required as evidence that concrete has attained specified strength for removal of formwork or shoring supporting weight of concrete in beams, slabs and other structural members. Furnish test cylinders and data to verify strength for early form removal.
 - a. Field-cured Test Cylinders: When field-cured test cylinders reach specified removal strength, formwork or shoring may be removed from respective concrete placements.
 - b. Laboratory-cured Test Cylinders: When concrete has been cured as specified for structural concrete for same time period required by laboratory-cured cylinders to reach specified strength, formwork or shoring may be removed from respective concrete placements. Determine length of time that concrete has been cured by totaling the days or fractions of days, not necessarily consecutive, during which air temperature surrounding concrete is above 50 degrees F and concrete has been damp or thoroughly sealed against evaporation and loss of moisture.
 2. Compressive Strengths: The minimum concrete compressive strength for removal of formwork supporting weight of concrete is 75 percent of specified minimum 28-day strength for class of concrete involved.

3.04 RESHORING

- A. When reshoring is permitted, plan operations in advance and obtain Engineer's approval of such operations. While reshoring is under way, keep live load off new construction. Do not permit concrete in any beam, slab, column or other structural member to be subjected to combined dead and construction loads in excess of loads permitted for developed concrete strength at time of reshoring.
- B. Place reshores as soon as practicable after form-stripping operations are complete but in no case later than end of day on which stripping occurs. Tighten reshores to carry required loads without over stressing construction. Leave reshores in place until tests

representative of concrete being supported have reached specified strength at time of removal of formwork supporting weight of concrete.

- C. Floors supporting shores under newly-placed concrete: Leave original supporting shores in place, or re-shore. Locate reshores directly under shore position above. Extend reshoring over a sufficient number of stories to distribute weight of newly-placed concrete, forms and construction live loads in such manner that design superimposed loads of floors supporting shores are not exceeded.

3.05 FORM REUSE

- A. Do not reuse forms that are worn or damaged beyond repair. Thoroughly clean and recoat forms before reuse. For wood and plywood forms to be used for exposed smooth finish, sand or otherwise dress concrete contact surface to original condition or provide form liner facing material. For metal forms, straighten, remove dents and clean to return forms to original condition.

Table 03100A

TOLERANCES FOR FORMED SURFACES CONCRETE IN BUILDINGS**				
VARIATION FROM	VARIATION IN	FOR ANY 10-FOOT LENGTH	FOR ANY 20-FOOT LENGTH OR ANY BAY	MAXIMUM FOR ENTIRE DIMENSION
PLUMB OR SPECIFIED BATTER	LINES AND SURFACES OF COLUMNS, PIERS, WALLS AND ARRISES	1/4"	—	1"
	EXPOSED CORNER COLUMNS, CONTROL JOINT GROOVES, AND OTHER CONSPICUOUS LINES	—	1/4"	1/2"
LEVEL OR SPECIFIED GRADE	SLAB SOFFITS, CEILINGS, BEAM SOFFITS, AND ARRISES (MEASURED BEFORE REMOVAL OF SHORES)	1/4"	3/8"	3/4"
	EXPOSED LINTELS, SILLS, PARAPETS, HORIZONTAL GROOVES AND OTHER CONSPICUOUS LINES	—	1/4"	1/2"
DRAWING DIMENSIONS	POSITION OF LINEAR BUILDING LINES, COLUMNS, WALLS, AND PARTITIONS	—	1/2"	1"
	SIZE AND LOCATION OF SLEEVES, FLOOR OPENINGS AND WALL OPENINGS	—	—	±1/4"
	CROSS SECTION OF COLUMNS, BEAMS, SLABS, AND WALLS	—	—	+1/2", -1/4"
	FOOTINGS* IN PLAN	—	—	+2", -1/2"
	FOOTING MISPLACEMENT OR ECCENTRICITY IN DIRECTION OF ERROR (THE LESSER OF)	—	—	2% OF WIDTH OR 2"
	FOOTING THICKNESS DECREASE	—	—	5%
	FOOTING THICKNESS INCREASE	—	—	NO LIMIT
	STEP RISE IN FLIGHT OF STAIRS	—	—	±1/8"
	STEP TREAD IN FLIGHT OF STAIRS	—	—	±1/4"
	CONSECUTIVE STEP RISE	—	—	±1/16"
	CONSECUTIVE STEP TREAD	—	—	±1/8"
* Footing tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items. ** Includes water and wastewater process structures.				

TABLE 03100B

TOLERANCES FOR FORMED SURFACES CONCRETE IN BRIDGES, WHARVES AND MARINE STRUCTURES		
VARIATION FROM	VARIATION IN	MAXIMUM
PLUMB OR SPECIFIED BATTER	SURFACES OF COLUMNS, PIERS AND WALLS	1/2" in 10'
LEVEL OR SPECIFIED GRADE	TOP SURFACES OF SLABS	See Section 03345
	TOP SURFACES OF CURBS AND RAILINGS	3/16" in 10'
DRAWING DIMENSIONS	CROSS SECTION OF COLUMNS, CAPS, WALLS, BEAMS AND SIMILAR MEMBERS	+1/2", -1/4"
	THICKNESS OF DECK SLABS	+1/4", - 1/8"
	SIZE AND LOCATION OF SLAB AND WALL OPENINGS	± 1/2"
	FOOTINGS IN PLAN	+2", -1/2"
	FOOTING MISPLACEMENT OR ECCENTRICITY IN DIRECTION OF ERROR (THE LESSER OF)	2% of WIDTH OR 2"
	FOOTING THICKNESS DECREASE	5%
	FOOTING THICKNESS INCREASE	NO LIMIT
	STEP RISE IN FLIGHT OF STAIRS	±1/8"
	STEP TREAD IN FLIGHT OF STAIRS	±1/4"
	CONSECUTIVE STEP RISE	±1/16"
	CONSECUTIVE STEP TREAD	±1/8"

END OF SECTION

Section 03211
REINFORCING STEEL

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Structural concrete reinforcement and grouting of reinforcement dowel bars into hardened concrete.

1.02 UNIT PRICES

- A. No separate payment will be made for reinforcing steel or grouting that is part of the Work as bid. Include payment in unit price for structural concrete.
- B. Measurement for reinforcing steel installed as extra work is on a per-pound basis.
- C. Refer to Section 01025 - Measurement and Payment for unit price procedures.

1.03 REFERENCES

- A. ACI 315 - Details and Detailing of Concrete Reinforcement.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ASTM A 36 - Standard Specification for Structural Steel.
- D. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- E. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- F. ASTM A 497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
- G. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- H. ASTM A 675 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
- I. ASTM A 775/A 775M - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
- J. ASTM C 881 - Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- K. AWS D 1.4 - Structural Welding Code - Reinforcing Steel.
- L. WRI - Manual of Standard Practice for Welded Wire Fabric.
- M. CRSI MSP-1 - Manual of Standard Practice.

1.04 SUBMITTALS

- A. Conform to Section 01300 - Submittals.
- B. Shop Drawings:
 - 1. Submit shop drawings detailing reinforcement fabrication, bar placement location, splices, spacing, bar designation, bar type, length, size, bending, number of bars, bar support type and other pertinent information, including dimensions. Provide sufficient detail for placement of reinforcement without use of Contract Drawings. Information shall correspond directly to data listed on bill of materials.
 - 2. Use of reproductions of Contract Drawings by Contractor, Subcontractor, erector, fabricator or material supplier in preparation of shop drawings (or in lieu of preparation of shop drawings) signifies acceptance by that party of information shown thereon as correct, and acceptance of obligation to pay for any job expense, real or implied, arising due to errors that may occur thereon. Remove references to Design Professional of Record, including seals, when reproductions of Contract Drawings are used as shop drawings.
 - 3. Detail shop drawings in accordance with ACI 315, Figure 6.
 - 4. Submit shop drawings showing location of proposed additional construction joints as required under Section 03301 - Joints in Concrete Structures, and obtain approval of Engineer, prior to submitting reinforcing steel shop drawings.
- C. Bill of Materials: Submit with shop drawings.
- D. Product Data:
 - 1. Mechanical Bar Splices: Submit manufacturer's technical literature, including specifications and installation instructions.
 - 2. Epoxy grout proposed for anchoring reinforcing dowels to hardened concrete: Submit manufacturer's technical literature including recommended installation procedures.
- E. Certificates:
 - 1. Submit steel manufacturer's certificates of mill tests giving properties of steel proposed for use. List manufacturer's test number, heat number, chemical analysis, yield point, tensile strength and percentage of elongation. Identify proposed location of steel in work.
 - 2. Foreign-manufactured reinforcing bars shall be tested for conformance to ASTM requirements by a certified independent testing laboratory located in United States. Certification from any other source is not acceptable. Submit test reports for review. Do not begin fabrication of reinforcement until material has been approved.

1.05 HANDLING AND STORAGE

- A. Store steel reinforcement above ground on platforms, skids or other supports. Protect reinforcing from mechanical injury, surface deterioration and formation of excessive, loose or flaky rust caused by exposure to weather. Protect epoxy-coated reinforcing from formation of any amount of rust.

1.06 QUALITY ASSURANCE

- A. Notify Engineer at least 48 hours before concrete placement so that reinforcement may be inspected, and errors corrected, without delaying Work.

PART 2 P R O D U C T S

2.01 MATERIAL

- A. Reinforcing Bars: Deformed bars conforming to ASTM A 615, grade as indicated on Drawings, except column spirals and those shown on Drawings to be smooth bars. Where grade is not shown on Drawings, use Grade 60.
- B. Smooth Bars: Where indicated on Drawings, use smooth bars conforming to ASTM A 36; ASTM A 615, Grade 60; or ASTM A 675, Grade 70.
- C. Column Spirals: Bars conforming to ASTM A 615, Grade 60, or wire conforming to ASTM A 82.
- D. Epoxy-Coated Deformed Bars, Column Spirals and Smooth Bars: Conform to ASTM A 775/A 775M.
- E. Welded Wire Fabric:
 - 1. Welded Smooth Wire Fabric: Conform to ASTM A 185.
 - 2. Welded Deformed Wire Fabric: Conform to ASTM A 497.
 - 3. Provide wire size, type and spacing as shown. Where type is not shown on Drawings, use welded smooth wire fabric.
 - 4. Furnish welded wire fabric in flat sheets only.
- F. Tie Wire: 16-1/2 gage or heavier annealed steel wire. Use plastic-coated tie wire with epoxy-coated reinforcing steel.
- G. Bar Supports: Provide chairs, riser bars, ties and other accessories made of plastic or metal, except as otherwise specified. Use bar supports and accessories of sizes required to provide required concrete cover. Where concrete surfaces are exposed to weather, water or wastewater, provide plastic accessories only; do not use galvanized or plastic-tipped metal in such locations. Provide metal bar supports and accessories rated Class 1 or 2 conforming to CRSI MSP-1 Manual of Standard Practice. Use epoxy-coated bar supports with epoxy-coated reinforcing bars.
- H. Slabs on Grade: Provide chairs with sheet metal bases or provide precast concrete bar supports 3 inches wide, 6 inches long, and thick enough to allow required cover. Embed tie wires in 3-inch by 6-inch side.
- I. Mechanical Bar Splices:

1. Conform to ACI 318; use where indicated on Drawings.
 - a. Compression splices shall develop ultimate stress of reinforcing bar.
 - b. Tension splices shall develop 125 percent of minimum yield point stress of reinforcing bar.
2. Regardless of chemical composition of steel, any heat effect shall not adversely affect performance of reinforcing bar.

J. Welded Splices:

1. Provide welded splices where shown and where approved by the Engineer. Welded splices of reinforcing steel shall develop a tensile strength exceeding 125 percent of the yield strength of the reinforcing bars connected.
2. Provide materials for welded splices conforming to AWS D1.4.

K. Epoxy Grout: High-strength rigid epoxy adhesive, conforming to ASTM C 881, Type IV, manufactured for purpose of anchoring dowels into hardened concrete and the moisture condition, application temperature and orientation of the hole to be filled. Unless otherwise shown, depth of embedment shall be as required to develop the full tensile strength (125 percent of yield strength) of dowel, but not less than 12 diameters.

2.02 FABRICATION

- A. Bending: Fabricate bars to shapes indicated on Drawings by cold bending. Bends shall conform to minimum bend diameters specified in ACI 318. Do not straighten or rebend bars. Fabricate epoxy-coated reinforcing steel to required shapes in a manner that will not damage epoxy coating. Repair any damaged epoxy coating with patching material conforming to Item 4.4 of ASTM A 775/A 775M.
- B. Splices:
1. Locate splices as indicated on Drawings. Do not locate splices at other locations without approval of Engineer. Use minimum number of splices located at points of minimum stress. Stagger splices in adjacent bars.
 2. Length of lap splices: As shown on Drawings.
 3. Prepare ends of bars at mechanical splices in accordance with splice manufacturer's requirements.
- C. Construction Joints: Unless otherwise shown, continue reinforcing through construction joints.
- D. Bar Fabrication Tolerances: Conform to tolerances listed in ACI 315, Figures 4 and 5.
- E. Standard Hooks: Conform to the requirements of ACI 318.
- F. Marking: Clearly mark bars with waterproof tags showing number of bars, size, mark, length and yield strength. Mark steel with same designation as member in which it occurs.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean reinforcement of scale, loose or flaky rust and other foreign material, including oil, mud or coating that will reduce bond to concrete.

3.02 INSTALLATION

- A. Placement Tolerances: Place reinforcement within tolerances of Table 03211A at the end of this Section. Bend tie wire away from forms to maintain the specified concrete coverage.
- B. Interferences: Maintain 2-inch clearance from embedded items. Where reinforcing interferes with location of other reinforcing steel, conduit or embedded items, bars may be moved within specified tolerances or one bar diameter, whichever is greater. Where greater movement of bars is required to avoid interference, notify Engineer. Do not cut reinforcement to install inserts, conduit, mechanical openings or other items without approval of Engineer.
- C. Concrete Cover: Provide clear cover measured from reinforcement to face of concrete as listed in Table 03211B at the end of this Section, unless otherwise indicated on Drawings.
- D. Placement in Forms: Use spacers, chairs, wire ties and other accessory items necessary to assemble, space and support reinforcing properly. Provide accessories of sufficient number, size and strength to prevent deflection or displacement of reinforcement due to construction loads or concrete placement. Use appropriate accessories to position and support bolts, anchors and other embedded items. Tie reinforcing bars at each intersection, and to accessories. Blocking reinforcement with concrete or masonry is prohibited.
- E. Placement for Concrete on Ground: Support bar and wire reinforcement on chairs with sheet metal bases or precast concrete blocks spaced at approximately 3 feet on centers each way. Use minimum of one support for each 9 square feet. Tie supports to reinforcing bars and wires.
- F. Vertical Reinforcement in Columns: Offset vertical bars by at least one bar diameter at splices. Provide accurate templates for column dowels to ensure proper placement.
- G. Splices:
 - 1. Do not splice bars, except at locations indicated on Drawings or reviewed shop drawings, without approval of Engineer.
 - 2. Lap Splices: Unless otherwise shown or noted, Class B, conforming to ACI 318-89, Section 12.15.1. Tie securely with wire prior to concrete placement, to prevent displacement of splices during concrete placement.
 - 3. Mechanical Bar Splices: Use only where indicated on Drawings or approved by the Engineer. Install in accordance with manufacturer's instructions.
 - a. Couplers located at a joint face shall be of a type which can be set either flush or recessed from the face as shown. Seal couplers prior to

- concrete placement to completely eliminate concrete or cement paste from entering.
- b. Couplers intended for future connections: Recess 1/2 inch minimum from concrete surface. After concrete is placed, plug coupler and fill recess with sealant to prevent contact with water or other corrosive materials.
 - c. Unless noted otherwise, match mechanical coupler spacing and capacity to that shown for the adjacent reinforcing.
- H. Construction Joints: Place reinforcing continuous through construction joints, unless noted otherwise.
- I. Welded Wire Fabric: Install wire fabric in as long lengths as practicable. Unless otherwise indicated on Drawings, lap adjoining pieces at least 6 inches or one full mesh plus 2 inches, whichever is larger. Lace splices with wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps. Conform to WRI - Manual of Standard Practice for Welded Wire Fabric.
- J. Field Bending: Shape reinforcing bent during construction operations to conform to Drawings. Bars shall be cold-bent; do not heat bars. Closely inspect reinforcing for breaks. When reinforcing is damaged, replace, Cadweld, or otherwise repair, as directed by Engineer. Do not bend reinforcement after it is embedded in concrete.
- K. Epoxy-coated Reinforcing Steel: Install in accordance with Paragraph 3.02J, Field Bending, and in a manner that will not damage epoxy coating. Repair damaged epoxy coating with patching material as specified in Paragraph 2.02A, Bending.
- L. Field Cutting: Cut reinforcing bars by shearing or sawing. Do not cut bars with cutting torch.
- M. Welding of reinforcing bars is prohibited, except where shown on Drawings.
- 3.03 GROUTING OF REINFORCING AND DOWEL BARS
- A. Use epoxy grout for anchoring reinforcing and dowel steel to existing concrete in accordance with epoxy manufacturer's instructions. Drill hole not more than 1/4 inch larger than steel bar diameter (including height of deformations for deformed bars) in existing concrete. Just before installation of steel, blow hole clean of all debris using compressed air. Partially fill hole with epoxy, using enough epoxy so when steel bar is inserted, epoxy grout will completely fill hole around bar. Dip end of steel bar in epoxy and twist bar while inserting into partially-filled hole.

Table 03211A

REINFORCEMENT PLACEMENT TOLERANCES

PLACEMENT	TOLERANCE IN INCHES
Clear Distance - To formed soffit: To other formed surfaces: Minimum spacing between bars:	 -1/4 ±1/4 -1/4
Clear distance from unformed surface to top reinforcement - Members 8 inches deep or less: Members more than 8 inches deep but less than 24 inches deep: Members 24 inches deep or greater: Uniform spacing of bars (but the required number of bars shall not be reduced): Uniform spacing of stirrups and ties (but the required number of stirrups and ties shall not be reduced):	 ±1/4 -1/4, +1/2 -1/4, +1 ±2 ±1
Longitudinal locations of bends and ends of reinforcement - General: Discontinuous ends of members: Length of bar laps:	 ±2 ±1/2 -1-1/2
Embedded length - For bar sizes No. 3 through 11: For bar sizes No. 14 and 18:	 -1 -2

Table 03211B

MINIMUM CONCRETE COVER FOR REINFORCEMENT

SURFACE	MINIMUM COVER IN INCHES
Slabs and Joists - Top and bottom bars for dry conditions - No. 14 and No. 18 bars: No. 11 bars and smaller:	1-1/2 1
Formed concrete surfaces exposed to earth, water or weather; over, or in contact with, sewage; and for bottoms bearing on work mat, or slabs supporting earth cover - No. 5 bars and smaller: No. 6 through No. 18 bars:	1-1/2 2
Beams and Columns - For dry conditions - Stirrups, spirals and ties: Principal reinforcement: Exposed to earth, water, sewage or weather - Stirrups and ties: Principal reinforcement:	1-1/2 2 2 2-1/2
Walls - For dry conditions - No. 11 bars and smaller: No. 14 and No. 18 bars: Formed concrete surfaces exposed to earth, water, sewage or weather, or in contact with ground - Circular tanks with ring tension: All others:	1 1-1/2 2 2
Footings and Base Slabs - At formed surfaces and bottoms bearing on concrete work mat: At unformed surfaces and bottoms in contact with earth: Over top of piles: Top of footings -- same as slabs	 2 3 2

END OF SECTION

Section 03310
STRUCTURAL CONCRETE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Cast-in-place normal-weight structural concrete and mass concrete.

1.02 UNIT PRICES

- A. Measurement for structural concrete is on lump-sum basis for each structure as bid. Payment includes related work performed on these structures in accordance with related sections of these Specifications.
- B. Measurement for extra structural concrete is on cubic-yard basis. Payment includes related work performed in accordance with related sections.
- C. Refer to Section 01270 - Measurement and Payment for unit price procedures.

1.03 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings.
- B. ACI 304.2R - Placing Concrete by Pumping Methods
- C. ACI 305R - Hot Weather Concreting.
- D. ACI 306.1 - Standard Specification for Cold Weather Concreting.
- E. ACI 309R - Guide for Consolidation of Concrete.
- F. ACI 318 - Building Code Requirements for Reinforced Concrete.
- G. ACI 350R - Environmental Engineering Concrete Structures.
- H. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- I. ASTM C 33 - Standard Specification for Concrete Aggregates.
- J. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- K. ASTM C 42 - Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- L. ASTM C 88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- M. ASTM C 94 - Standard Specifications for Ready-Mixed Concrete.
- N. ASTM C 127 - Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.

- O. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - P. ASTM C 136 - Sieve Analyses of Fine and Coarse Aggregates.
 - Q. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
 - R. ASTM C 150 - Standard Specification for Portland Cement.
 - S. ASTM C 157 - Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
 - T. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - U. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - V. ASTM C 192 - Method of Making and Curing Concrete Test Specimens in the Laboratory.
 - W. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - X. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - Y. ASTM C 330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
 - Z. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
 - AA. ASTM C 535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - BB. ASTM C 567 - Standard Test Method for Unit Weight of Structural Lightweight Concrete.
 - CC. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
 - DD. Concrete Plant Manufacturer's Bureau (CPMB), Plant Mixer Manufacturers Division: Concrete Plant Mixer Standards.
 - EE. National Ready-Mixed Concrete Association (NRMCA): Certification of Ready-Mixed Concrete Production Facilities (checklist with instructions).
 - FF. John Wiley and Sons, Interscience Publishers Division, "Encyclopedia of Industrial Chemical Analysis," Vol. 15, Page 230 (alkalinity test procedure).
- 1.04 DEFINITIONS
- A. Mass Concrete: Concrete sections 4 feet or more in least dimension.
 - B. Hot Weather: Any combination of high air temperature, low relative humidity and wind velocity tending to impair quality of fresh or hardened concrete or otherwise resulting in abnormal properties.

- C. Cold Weather: Period when, for more than 2 successive days, mean daily temperature is below 40 degrees F.

1.05 SUBMITTALS

- A. Conform to Section 01330 - Submittals.
- B. Mill Certificates: Required for bulk cement.
- C. Design Mixes:
 - 1. Submit test data on proposed design mixes for each type of concrete in the Work, including each class, and variations in type, source or quantity of material. Include type, brand and amount of cementitious materials; type, brand and amount of each admixture; slump; air content; aggregate sources, gradations, specific gravity and absorption; total water (including moisture in aggregate); water/cement ratio; compressive strength test results for 7 and 28 days; and shrinkage tests for Class C and D concrete at 21 or 28 days of drying.
 - 2. Submit abrasion loss and soundness test results for limestone aggregate.
 - 3. Testing of aggregates, including sieve analysis, shall be performed by a certified independent testing laboratory. Tests shall have been performed no earlier than 3 months before Notice to Proceed.
 - 4. Provide standard deviation data for plant producing concrete. Data shall include copies of laboratory test results and standard deviation calculated in accordance with ACI 318, Item 5.3.1. Laboratory tests shall have been performed within past 12 months. When standard deviation data is not available, comply with ACI 318, Table 5.3.2.2.
 - 5. Review and acceptance of mix design does not relieve Contractor of responsibility to provide concrete of quality and strength required by these Specifications.
- D. Admixtures: Submit manufacturer's technical information, including following:
 - 1. Air-Entraining Admixture: Give requirements to control air content under all conditions, including temperature variations and presence of other admixtures.
 - 2. Chemical Admixtures: Give requirements for quantities and types to be used under various temperatures and job conditions to produce uniform, workable concrete mix. Submit evidence of compatibility with other admixtures and cementitious materials proposed for use in design mix.
- E. High-range Water Reducer (Superplasticizer): When proposed for use, submit manufacturer's technical information and instructions for use of superplasticizer. State whether superplasticizer will be added at ready-mix plant or job site. When superplasticizer will be added at job site, submit proposed plan for measuring and adding superplasticizer to concrete mix at job site, and establish dosing area on site with holding tanks and metering devices. When superplasticizer is to be added at

ready-mix plant, submit contingency plans for adding additional superplasticizer at job site when required due to delay in placing concrete. Identify portions of Work on which superplasticizer is proposed for use.

- F. Hot and Cold Weather Concreting: Submit, when applicable, proposed plans for hot and cold weather concreting. Review and acceptance of proposed procedure will not relieve Contractor of responsibility for quality of finished product.
- G. Project Record Drawings: Accurately record actual locations of embedded utilities and components which are concealed from view.

1.06 QUALITY ASSURANCE

- A. Provide necessary controls during evaluation of materials, mix designs, production and delivery of concrete, placement and compaction to assure that the Work will be accomplished in accordance with Contract Documents. Maintain records of concrete placement. Record dates, locations, quantities, air temperatures, and test samples taken.
- B. Code Requirements: Concrete construction for buildings shall conform to ACI 318. Concrete construction for water and wastewater treatment and conveying structures shall conform to ACI 318 with modifications by ACI 350R, Item 2.6. Where this Specification conflicts with ACI 318 or ACI 350R, this Specification governs.
- C. Testing and Other Quality Control Services:
 - 1. Concrete testing required in this section, except concrete mix design, limestone aggregate test data, and testing of deficient concrete, will be performed by an independent commercial testing laboratory employed and paid by the Authority in accordance with Section 01454 - Testing Laboratory Services.
 - 2. Provide material for and cooperate fully with Authority's testing laboratory technician in obtaining samples for required tests.
 - 3. Standard Services: The following testing and quality control services will be provided by Authority in accordance with Section 01454, Testing Laboratory Services:
 - a. Verification that plant equipment and facilities conform to NRMCA "Certification of Ready-Mix Concrete Production Facilities".
 - b. Testing of proposed materials for compliance with this Specification.
 - c. Review of proposed mix design submitted by Contractor.
 - d. Obtaining production samples of materials at plants or stockpiles during work progress and testing for compliance with this Specification.
 - e. Strength testing of concrete according to following procedures:
 - 1) Obtaining samples for field test cylinders from every 100 cubic yards and any portion less than 100 cubic yards for each mix

- design placed each day, according to ASTM C 172, with each sample obtained from a different batch of concrete on a representative, random basis. Selecting test batches by any means other than random numbers chosen before concrete placement begins is not allowed.
- 2) Molding four specimens from each sample according to ASTM C 31, and curing under standard moisture and temperature conditions as specified in Sections 7(a) and (b) of ASTM C 31.
 - 3) Testing two specimens at 7 days and two specimens at 28 days according to ASTM C 39, reporting test results averaging strengths of two specimens. However, when one specimen evidences improper sampling, molding or testing, it will be discarded and remaining cylinder considered test result. When high-early-strength concrete is used, specimens will be tested at 3 and 7 days.
- f. Air content: For each strength test, determination of air content of normal weight concrete according to ASTM C 231.
 - g. Slump: For each strength test, and whenever consistency of concrete appears to vary, conducting slump test in accordance with ASTM C 143.
 - h. Temperature: For each strength test, checking concrete temperature in accordance with ASTM C 1064.
 - i. Lightweight concrete: For each strength test, or more frequently when requested by Engineer, determination of air content by ASTM C 567 and unit weight by ASTM C 567.
 - j. Monitoring of current and forecasted climatic conditions to determine when rate of evaporation, as determined by Figure 2.1.5 of ACI 305R, will produce loss of 0.2 pounds of water, or more, per square foot per hour. Testing lab representative will advise Contractor to use hot weather precautions when such conditions will exist during concrete placement, and note on concrete test reports when Contractor has been advised that hot weather conditions will exist.
 - k. Class A and D Concrete Shrinkage Tests: Performance of drying shrinkage tests for trial batches as follows:
 - 1) Preparation and Testing of Specimens: Compression and drying shrinkage test specimens will be taken in each case from the same concrete sample; shrinkage tests will be considered a part of the normal compression tests for the project. 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10

inches, fabricated, cured, dried and measured in accordance with ASTM C 157, modified as follows:

- a) Wet curing: Remove specimens from molds at an age of 23 hours $\pm$ 1 hour after trial batching and immediately immerse in water at 70 degrees F $\pm$ 3 degrees F for at least 30 minutes;
 - b) Measure within 30 minutes after first 30 minutes of immersion to determine original length (not to be confused with "base length");
 - c) Then submerge in saturated limewater, at 73 degrees F $\pm$ 3 degrees F, for 7 days;
 - d) Then measure at age 7 days to establish "base length" for drying shrinkage calculations ("zero" days drying age);
 - e) Calculate expansion (base length expressed as a percentage of original length);
 - f) Immediately store specimens in a temperature- and humidity-controlled room maintained at 73 degrees F, $\pm$ 3 degrees F and 50 percent $\pm$ 4 percent relative humidity, for the remainder of the test.
 - g) Measure to determine shrinkage, expressed as percentage of base length. Compute the drying shrinkage deformation of each specimen as the difference between the base length (at "zero" days drying age) and the length after drying at each test age. Compute the average drying shrinkage deformation of the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch, disregard the results obtained from that specimen. Report results of shrinkage tests to the nearest 0.001 percent of shrinkage.
 - h) Report shrinkage separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
4. Additional Testing and Quality Control Services: The following will be performed by an independent commercial testing laboratory employed and paid by the Authority in accordance with Section 01454, Testing Laboratory Services, when requested by Engineer.
- a. Checking of batching and mixing operations.

- b. Review of manufacturer's report of each cement shipment and conducting laboratory tests of cement.
 - c. Molding and testing reserve 7-day cylinders or field cylinders.
 - d. Conducting additional field tests for slump, concrete temperature and ambient temperature.
 - e. Alkalinity Tests: For concrete used in sanitary structures, one test for each structure. Perform alkalinity tests on concrete covering reinforcing steel on the inside of the pipe or structure in accordance with "Encyclopedia of Industrial Chemical Analysis," Vol. 15, page 230.
5. Contractor shall provide the following testing and quality control services:
- a. Employ an independent commercial testing laboratory, acceptable to Authority, to prepare and test design mix for each class of concrete for which material source has been changed.
 - b. Notify commercial testing laboratory employed by Authority 24 hours prior to placing concrete.
6. Testing of deficient concrete in place:
- a. When averages of three consecutive strength test results fail to equal or exceed specified strength, or when any individual strength test result falls below specified strength by more than 500 psi, strength of concrete shall be considered potentially deficient and core testing, structural analysis or load testing may be required by Engineer.
 - b. When concrete in place proves to be deficient, Contractor shall pay costs, including costs due to delays, incurred in providing additional testing and analysis services provided by the Engineer, or the independent commercial testing laboratory selected by the Authority.
 - c. Replace concrete work judged inadequate by core tests, structural analysis or load tests at no additional cost to the Authority.
 - d. Core Tests:
 - 1) Obtain and test cores in accordance with ASTM C 42. Where concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before test; test dry. Where concrete in structure will be more than superficially wet under service conditions, test cores after moisture conditioning in accordance with ASTM C 42.
 - 2) Take at least three representative cores from each member or area of concrete in place that is considered potentially deficient. Location of cores shall be determined by Engineer so as to least

impair strength of structure. When, before testing, one or more cores shows evidence of having been damaged during or after removal from structure, replace the damaged cores.

- 3) Concrete in area represented by core test will be considered adequate when average strength of cores is equal to at least 85 percent of specified strength, and when no single core is less than 75 percent of specified strength.
 - 4) Patch core holes in accordance with Section 03350 - Concrete Finishing.
- e. Structural Analysis: When core tests are inconclusive or impractical to obtain, Engineer may perform additional structural analysis at Contractor's expense to confirm safety of structure.
 - f. Load Tests: When core tests and structural analysis do not confirm safety of structure, load tests may be required, and their results evaluated, in accordance with ACI 318.
 - g. Testing by impact hammer, sonoscope, probe penetration tests (Windsor probe), or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in structure, to evaluate concrete strength in place, or for selecting areas to be cored. However, such tests, unless properly calibrated and correlated with other test data, shall not be used as basis for acceptance or rejection of structure's safety.

1.07 STORAGE AND HANDLING OF MATERIALS

- A. Cement: Store cement in weathertight buildings, bins or silos to provide protection from dampness and contamination and to minimize warehouse set. When there is any doubt as to expansive potential of shrinkage-compensating cements because of method or length of storage and exposure, laboratory test cement before use.
- B. Aggregate: Arrange and use aggregate stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding 3 feet in thickness. Complete each layer before next is started.
- C. Fine Aggregate: Before using, allow fine aggregate to drain until uniform moisture content is reached.
- D. Admixtures: Store admixtures to avoid contamination, evaporation or damage. For those used in form of suspensions or nonstable solutions, provide suitable agitating equipment to assure uniform distribution of ingredients. Protect liquid admixtures from freezing and other temperature changes which would adversely affect their characteristics.
- E. Lightweight Aggregates: Uniformly predampen lightweight aggregates as necessary to prevent excessive variations in moisture content. Allow predampened aggregates to

remain in stockpiles, under continuous fog spray, for minimum of 24 hours before use. Provide adequate drainage in stockpile areas to eliminate excess water and accumulation of contaminated fines.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Cement:

1. Use same brand of cement used in concrete mix design. Use only one brand of each type in each structure, unless otherwise indicated on Drawings.
2. Portland Cement: ASTM C 150, Type I or Type II, gray in color. Use Type III only when specifically authorized by Engineer in writing. Use Type II, including the requirements of Table 2, in construction of liquid-containing structures and cooling towers, unless shown otherwise on Drawings.

B. Admixtures:

1. Do not use calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions.
2. Air-Entraining Admixtures: ASTM C 260, compatible with other admixtures used.
3. Chemical Admixtures: Polymer type, nonstaining, chloride-free admixtures conforming to ASTM C 494, Type A, C, D or E.
4. High-Range Water Reducer (Superplasticizer): ASTM C 494, Type F or G, compatible with and by the same manufacturer as other admixtures.

C. Mixing Water: Use clean, potable water, free from harmful amounts of oils, acids, alkalis or other deleterious substances, meeting requirements of ASTM C 94.

D. Aggregates: Use coarse aggregate from only one source, and fine aggregate from only one source, for exposed concrete in any single structure.

1. Coarse Aggregate: Gravel, crushed gravel or crushed limestone conforming to ASTM C 33.
2. Fine Aggregate: Natural sand complying with ASTM C 33.
3. Limestone aggregate shall conform to ASTM C 33 and the following additional requirements: Clean, hard, strong and durable particles free of chemicals and coatings of silt, clay, or other fine materials that may affect hydration and bond of cement paste. Select crushed limestone: High-calcium limestone (minimum 95 percent CaCO_3 and maximum 3.5 percent MgCO_3) with maximum Los Angeles Abrasion loss of 38 percent, when tested in accordance with ASTM C 131 or ASTM C 535. Test aggregate for soundness in accordance with ASTM C 88; maximum loss shall not exceed 18 percent after 5 cycles of magnesium sulfate test.

4. Maximum size of coarse aggregate:
 - a. Normal weight concrete, except as noted below: 1-1/2 inches.
 - b. Formed members 6 inches or less in least dimension: 1/5 least dimension.
 - c. Slabs: 1/3 depth of slab.
 - d. Drilled shafts: 1/3 clearance between reinforcing steel, but not greater than 3/4 inch.
 - e. Concrete fill, seal slabs and bonded concrete topping in clarifiers: 3/8 inch.
5. Coarse aggregate for lightweight concrete: ASTM C 330. Grading limits: 3/4 inch to No. 4.
6. Abrasive Aggregate: Conform to requirements of Section 03350 - Concrete Finishing.
- E. Calcium Chloride: Not permitted.
- F. Evaporation Retardant: Masterbuilders "Confilm", Euclid "Eucobar", or equal.
- G. Miscellaneous Materials:
 1. Bonding Agent: Two-component modified epoxy resin.
 2. Vapor barrier: 6 mil clear polyethylene film of type recommended for below-grade application.
 3. Non-shrink grout: premixed compound consisting of non-metallic aggregate, cement and water-reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

2.02 CONCRETE MIX

- A. Objective: Select proportions of ingredients to produce concrete having proper placability, durability, strength, appearance, and other specified properties.
- B. Mix Design: Employ and pay an independent commercial testing laboratory, acceptable to Authority, to prepare and test mix designs for each type of concrete specified. Proportion mix design ingredients by weight. Submit mix designs and test results for approval.
 1. During the trial batches, aggregate proportions may be adjusted by the testing laboratory using two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor. Concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractor's preliminary mix design, or

whether the proportions have been adjusted during the trial batch process. Prepare trial batches using the aggregates, cement and admixtures proposed for the project. Make trial batches large enough to obtain 3 drying shrinkage test specimens and 6 compression test specimens from each batch. Shrinkage testing is required only for Class A and D concrete.

2. Determine compressive strength by testing 6-inch diameter by 12-inch high cylinders, made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Test 3 compression test cylinders at 7 days and 3 at 28 days. Average compressive strength for the 3 cylinders tested at 28 days for any given trial batch shall be not less than 125 percent of the specified compressive strength.
3. Perform sieve analysis of the combined aggregate for each trial batch according to of ASTM C 136. Report percentage passing each sieve.
4. In mix designs for Class A and D concrete, fine aggregate shall not exceed 41 percent of total aggregate by weight.

C. Shrinkage Limitations, Class A and D Concrete

1. Maximum concrete shrinkage for specimens cast in the laboratory from the trial batch: 0.036 percent as measured at 21-day drying age, or 0.042 percent at 28-day drying age. Use for construction only mix designs that meet trial batch shrinkage requirements. Shrinkage limitations apply only to Class A and D concrete.
2. Maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.
3. If the required shrinkage limitation is not met during construction, take any or all of the following actions, at no additional cost to the Authority, for securing the specified shrinkage requirements: Changing the source or aggregates, cement or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or its effects.

D. Selecting Ingredient Proportions for Concrete:

1. Proportion concrete mix according to ACI 301, Chapter 3.
2. Establish concrete mix design by laboratory trial batches prepared by independent testing laboratory, or on basis of previous field experience in accordance with provisions of ACI 318, Item 5.3; however, minimum cement content for each class of concrete shall not be less than specified.
3. Concrete mix design data submitted for review shall have average 28-day compressive strength calculated in accordance with ACI 318, Item 5.3.2.1. When data is not available to determine standard deviation in accordance with ACI 318, Item 5.3.1, average 28-day strength of mix design shall conform to ACI 318, Table 5.3.2.2.

E. Water-Cement Ratios:

1. Maximum allowable water-cement ratios shall be as follows:
 - a. Concrete for liquid-containing structures: 0.45.
 - b. Concrete subjected to brackish water, salt spray or deicers: 0.40.
 - c. All other concrete: 0.55.
2. Superplasticizer may be added to maintain specified maximum water-cement ratios. Include free water in aggregate in water-cement ratio computations.

F. Adjustment of Mix Proportions: After sufficient data becomes available during construction, mix may be adjusted upon approval of Engineer, in accordance with ACI 318, Item 5.5; however, minimum cement content for each class of concrete shall not be less than specified.

G. Entrained Air: Air-entrain all concrete except drilled shafts. Total air content in accordance with ASTM C 173: 4 to 6 percent.

H. Consistency, Workability, and Slump:

1. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce concrete which can be worked properly into place without segregation, and which can be compacted by vibratory methods as specified, to give the desired strength, density, impermeability and smoothness of surface. Change the quantity of water as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. Determine the consistency of the concrete in successive batches by slump tests in accordance with ASTM C 143. Slumps shall be as follows:

<u>Concrete Type</u>	<u>Minimum Slump</u>	<u>Maximum Slump</u>
Portland Cement Concrete:	2"	4"
Concrete to be dosed with superplasticizer:	1"	3"
Normal Weight Concrete after dosing with superplasticizer:	4"	9"
Lightweight Concrete after dosing with superplasticizer:	4"	7"
Drilled Shaft Concrete:	4"*	8"

* Minimum slump where drilled shafts are cast in temporary casings: 5 inches.

2. Specified slump shall apply at time when concrete is discharged at job site. Perform slump tests to monitor uniformity and consistency of concrete delivered to job site; however, do not use as basis for mix design. Do not exceed water-cement ratios specified.

- I. Admixtures: Proportion admixtures according to manufacturer's recommendations. Use of accelerator is permitted when air temperature is less than 40 degrees F. Use of retarder is permitted when temperature of placed concrete exceeds 65 degrees F.
- J. High-Range Water Reducers (Superplasticizers): Use superplasticizer to improve workability of concrete or delay hydration of cement, in accordance with requirements and recommendations of product manufacturer and approved submittals.
- K. Concrete Classification and Strength:

- 1. Strength: Conform to values for class of concrete indicated on Drawings for each portion of Work. Requirements are based on 28-day compressive strength. If high early-strength concrete is allowed, requirements are based on 7-day compressive strength.

- 2. Classification:

<u>Class (Normal- weight)</u>	<u>Minimum 28-Day Compressive Strength (psi)</u>	<u>Minimum Cement Content Pounds per Cubic Yard</u>

Concrete for Structures Containing Water or Wastewater

A	4000	564 (6 Sacks)
B	1500	329 (3-1/2 Sacks)
C	3000	470 (5 Sacks)
D	5000	658 (7 Sacks)
H	3000	611 (6-1/2 Sacks)

Concrete for Buildings, Slabs on Grade and Miscellaneous Structures

AB	4000	Not Applicable
BB	1500	Not Applicable
CB	3000	Not Applicable
DB	5000	Not Applicable

<u>Class (Light- weight)</u>	<u>Minimum 28-Day Compressive Strength (psi)</u>	<u>Minimum Cement Content Pounds per Cubic Yard</u>

E	3000	Not Applicable
F	4000	Not Applicable
G	5000	Not Applicable

- 3. Maximum size aggregate for Class H concrete: 3/8 inch. Maximum size aggregate for all other normal-weight concrete: 1-1/2 inches, except as specified in Paragraph 2.1 D.4.
- 4. When required strength is not obtained with minimum cement content as specified, add cement, lower water-cement ratio or provide other aggregates as necessary.

5. In addition to conforming to specified strength, lightweight concrete must be within specified unit weight limits. Maximum air-dry unit weight is 118 pounds per cubic foot; minimum is 110 pounds per cubic foot unless shown otherwise on Drawings. Determine air-dry unit weight in accordance with ASTM C 567. Correlate air-dry unit weight with fresh unit weight of the same concrete as a basis for acceptance during construction.

L. Use of Classes of Concrete:

1. Use classes of concrete as indicated on the Drawings and in other specifications.
2. Liquid-containing structures: If not otherwise indicated, use the following classes for structures containing water or wastewater and for utility applications in the locations described:
 - a. Class A: All reinforced concrete and where not otherwise defined.
 - b. Class B: Unreinforced concrete used for plugging pipes, seal slabs, thrust blocks and trench dams, unless indicated otherwise.
 - c. Class H: Fill and topping. Where concrete fill thickness exceeds 3 inches in the majority of a placement and is not less than 1.5 inches thick, Class A concrete may be used.
3. All other structures: If not otherwise indicated, use the following classes in the locations described:
 - a. Class AB: All reinforced concrete and where not otherwise defined.
 - b. Class CB: Duct banks; see Section 16402 - Underground Duct Banks for additional requirements.
 - c. Class BB: Unreinforced concrete fill under structures.

2.03 MIXING NORMAL WEIGHT CONCRETE

A. Conform to ACI 301, Chapter 7.

B. Ready-Mixed Concrete:

1. Measure, batch, mix and transport ready-mixed concrete according to ASTM C 94. Plant equipment and facilities shall conform to NRMCA "Certification of Ready Mixed Concrete Production Facilities".
2. Provide batch tickets with information specified in ASTM C 94. Deliver batch ticket with concrete and give to Authority's on-site testing laboratory representative.

C. Batch Mixing at Site:

1. Mix concrete in batch mixer conforming to requirements of CPMB "Concrete Plant Mixer Standards". Use mixer equipped with suitable charging hopper, water storage tank and water measuring device. Batch mixer shall be capable

of mixing aggregates, cement and water into uniform mass within specified mixing time, and of discharging mix without segregation. Operate mixer according to rated capacity and recommended revolutions per minute printed on manufacturer's rating plate.

2. Charge batch into mixer so some water will enter before cement and aggregates. Keep water running until one-fourth of specified mixing time has elapsed. Provide controls to prevent discharging until required mixing time has elapsed. When concrete of normal weight is specified, provide controls to prevent addition of water during mixing. Discharge entire batch before mixer is recharged.
3. Mix each batch of 2 cubic yards or less for not less than 1 minute and 30 seconds. Increase minimum mixing time 15 seconds for each additional cubic yard or fraction of cubic yard.
4. Keep mixer clean. Replace pick-up and throw-over blades in drum when they have lost 10 percent of original depth.

D. Admixtures:

1. Charge air-entraining and chemical admixtures into mixer as solution using automatic dispenser or similar metering device. Measure admixture to accuracy within ± 3 percent. Do not use admixtures in powdered form.
2. Two or more admixtures may be used in same concrete, provided that admixtures in combination retain full efficiency and have no deleterious effect on concrete or on properties of each other. Inject admixtures separately during batching sequence.
3. Add retarding admixtures as soon as practicable after addition of cement.

E. Temperature Control:

1. When ambient temperature falls below 40 degrees F, keep as-mixed temperature above 55 degrees F to maintain concrete above minimum placing temperature.
2. When water or aggregate has been heated, combine water with aggregate in mixer before cement is added. Do not add cement to mixtures of water and aggregate when temperature of mixture is greater than 100 degrees F.
3. In hot weather, maintain temperature of concrete below maximum placing temperature. When necessary, temperature may be lowered by cooling ingredients, cooling mixer drum by fog spray, using chilled water or well-crushed ice in whole or part for added water, or arranging delivery sequence so that time of transport and placement does not generate unacceptable temperatures.
4. Submit hot weather and cold weather concreting plans for approval.

2.04 MIXING LIGHTWEIGHT CONCRETE

- A. Determining Absorption of Aggregates: Mixing procedures vary according to total absorption by weight of lightweight aggregates. Determine total absorption by weight before predamping in accordance with ASTM C 127.
- B. Ten Percent or Less Absorption: Follow same requirements as for mixing normal-weight concrete when preparing concrete made with low-absorptive lightweight aggregates having 10 percent or less total absorption by weight. To be low-absorptive, aggregates must absorb less than 2 percent additional water in first hour after mixing.
- C. More Than 10 Percent Absorption: Batch and mix concrete made with lightweight aggregates having more than 10 percent total absorption by weight, as follows:
 - 1. Place approximately 80 percent of mixing water in mixer.
 - 2. If aggregates are pre-dampened, add air-entraining admixture and all aggregates. Mix for minimum of 30 seconds, or 5 to 10 revolutions of truck mixer.
 - 3. When aggregates have not been predampened, mix aggregates and water for minimum of 1 minute and 30 seconds, or 15 to 30 revolutions of truck mixer. Then add air-entraining admixture and mix for additional 30 seconds.
 - 4. Then, in the following sequence, add specified or permitted admixtures (other than air-entraining agent), all cement, and mixing water previously withheld.
 - 5. Complete mixing using procedures for normal-weight concrete.

2.05 MASS CONCRETE

- A. Do not use high early-strength cement (Type III) or accelerating admixtures.
- B. Use high-range water-reducing admixture (superplasticizer) to minimize water content and cement content.
- C. Specified water-reducing retarding admixture may be required to prevent cold joints when placing large quantities of concrete, to permit revibration of concrete, to offset effects of high temperature in concrete or weather, and to reduce maximum temperature or rapid temperature rise.

2.06 EQUIPMENT

- A. Select equipment of size and design to ensure continuous flow of concrete at delivery end. Conform to following equipment and operations requirements.
- B. Truck mixers, agitators and manner of operation: Conform to ASTM C 94. Use of non-agitating equipment for transporting concrete is not permitted.
- C. Belt conveyors: Configure horizontally, or at a slope causing no segregation or loss. Use approved arrangement at discharge end to prevent separation. Discharge long runs without separation into hopper.
- D. Chutes: Metal or metal-lined (other than aluminum). Arrange for vertical-to-horizontal slopes not more than 1 to 2 nor less than 1 to 3. Chutes longer than 20 feet

or not meeting slope requirements may be used if concrete is discharged into hopper before distribution.

- E. Do not use aluminum or aluminum-alloy pipe or chutes for conveying concrete.

PART 3 EXECUTION

3.01 SPECIAL CONSIDERATIONS

- A. **Concreting Under Water:** Not permitted except where shown otherwise on Drawings or approved by Engineer. When shown or permitted, deposit concrete under water by methods acceptable to the Engineer so fresh concrete enters mass of previously-placed concrete from within, causing water to be displaced with minimum disturbance at surface of concrete.
- B. **Protection from Adverse Weather:** Unless adequate protection is provided or Engineer's approval is obtained, do not place concrete during rain, sleet, snow or freezing weather. Do not permit rainwater to increase mixing water or to damage surface finish. If rainfall occurs after placing operations begin, provide adequate covering to protect Work.

3.02 PREPARATION OF SURFACES FOR CONCRETING

- A. **Earth Surfaces:**
 - 1. Under interior slabs on grade, install vapor barrier. Lap joints at least 6 inches and seal watertight with tape, or sealant applied between overlapping edges and ends. repair vapor barrier damaged during placement of reinforcing and inserts with vapor barrier material; lap over damaged areas at least 6 inches and seal watertight.
 - 2. **Other Earth Surfaces:** Thoroughly wet by sprinkling prior to placing concrete, and keep moist by frequent sprinkling up to time of placing concrete thereon. Remove standing water. Surfaces shall be free from standing water, mud and debris at the time of placing concrete.
- B. **Construction Joints:**
 - 1. **Definition:** Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been interrupted so that, in the judgement of the Engineer, new concrete cannot be incorporated integrally with that previously placed.
 - 2. **Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, use forms or other means to shape the working face to secure proper union with subsequent work. Make construction joints only where acceptable to the Engineer.
 - 3. **Preparation:** Give horizontal joint surfaces a compacted, roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, clean joint surfaces of laitance, loose or defective concrete and foreign material

- by hydroblasting or sandblasting (exposing aggregate), roughen surface to expose aggregate to a depth of at least 1/4 inch and wash thoroughly. Remove standing water from the construction joint surface before new concrete is placed.
4. After surfaces have been prepared cover approximately horizontal construction joints with a 3-inch lift of a grout mix consisting of Class A concrete batched without coarse aggregate; place and spread grout uniformly. Place wall concrete on the grout mix immediately thereafter.
- C. Set and secure reinforcement, anchor bolts, sleeves, inserts and similar embedded items in the forms where indicated on Contract Drawings, shop drawings and as otherwise required. Obtain Engineer's acceptance before concrete is placed. Accuracy of placement is the sole responsibility of the Contractor.
- D. Place no concrete until at least 4 hours after formwork, inserts, embedded items, reinforcement and surface preparation have been completed and accepted by the Engineer. Clean surfaces of forms and embedded items that have become encrusted with grout or previously-placed concrete before placing adjacent concrete.
- E. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), thoroughly clean and roughen the surface of the old concrete by hydro-blasting or sandblasting (exposing aggregate). Coat joint surface with epoxy bonding agent following manufacturer's written instructions, unless indicated otherwise. Unless noted otherwise, this provision does not apply to vertical wall joints where waterstop is installed.
- F. Protection from Water: Place no concrete in any structure until water entering the space to be filled with concrete has been properly cut off or diverted and carried out of the forms, clear of the work. Deposit no concrete underwater. Do not allow still water to rise on any concrete until concrete has attained its initial set. Do not allow water to flow over the surface of any concrete in a manner and at a velocity that will damage the surface finish of the concrete. Pumping, dewatering and other necessary operations for removing ground water, if required, are subject to Engineer's review.
- G. Corrosion Protection: Position and support pipe, conduit, dowels and other ferrous items to be embedded in concrete construction prior to placement of concrete so there is at least a 2 inch clearance between them and any part of the concrete reinforcement. Do not secure such items in position by wiring or welding them to the reinforcement.
- H. Where practicable, provide for openings for pipes, inserts for pipe hangers and brackets, and setting of anchors during placing of concrete.
- I. Accurately set anchor bolts and maintain in position with templates while they are being embedded in concrete.
- J. Cleaning: Immediately before concrete is placed, thoroughly clean dirt, grease, grout, mortar, loose scale, rust and other foreign substances from surfaces of metalwork to be in contact with concrete.

3.03 HANDLING, TRANSPORTING AND PLACING CONCRETE

- A. Conform to applicable requirements of Chapter 8 of ACI 301 and this Section. Use no aluminum materials in conveying concrete.
- B. Rejected Work: Remove concrete found to be defective or non-conforming in materials or workmanship. Replace rejected concrete with concrete meeting requirements of Contract Documents, at no additional cost to the Authority.
- C. Unauthorized Placement: Place no concrete except in the presence of the Engineer. Notify the Engineer in writing at least 24 hours before placement of concrete.
- D. Placement in Wall Forms:
 - 1. Do not drop concrete through reinforcing steel.
 - 2. Do not place concrete in any form so as to leave an accumulation of mortar on form surfaces above the concrete.
 - 3. Pump concrete or use hoppers and, if necessary, vertical ducts of canvas, rubber or metal (other than aluminum) for placing concrete in forms so it reaches the place of final deposit without separation. Free fall of concrete shall not exceed 4 feet below the ends of pump hoses, ducts, chutes or buggies. Uniformly distribute concrete during depositing.
 - 4. Do not displace concrete in forms more than 6 feet in horizontal direction from place where it was originally deposited.
 - 5. Deposit in uniform horizontal layers not deeper than 2 feet; take care to avoid inclined layers or inclined construction joints except where required for sloping members.
 - 6. Place each layer while the previous layer is still soft. Rate of placement shall not exceed 5 feet of vertical rise per hour.
 - 7. Provide sufficient illumination in form interior so concrete at places of deposit is visible from the deck or runway.
- E. Conveyors and Chutes: Design and arrange ends of chutes, hopper gates and other points of concrete discharge in the conveying, hoisting and placing system so concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyors, if used, shall be of a type acceptable to the Engineer. Do not use chutes longer than 50 feet. Slope chutes so concrete of specified consistency will readily flow. If a conveyor is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyors and chutes shall be covered.
- F. Placement of Slabs: In hot or windy weather, conducive to plastic shrinkage cracks, apply evaporation retardant to slab after screeding in accordance with manufacturer's instructions and recommendations. Do not use evaporation retardant to increase water content of the surface cement paste. Place concrete for sloping slabs uniformly from the bottom of the slab to the top, for the full width of the placement. As work

progresses, vibrate and carefully work concrete around slab reinforcement. Screed the slab surface in an up-slope direction.

- G. Concrete Temperature: When placed, not more than 90 degrees F nor less than 55 degrees F for sections less than 12 inches thick, nor less than 50 degrees for all other sections. Do not heat concrete ingredients to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. When concrete temperature is 85 degrees F or above, do not exceed 60 minutes between introduction of cement to the aggregates and discharge. When the weather is such that the concrete temperature would exceed 90 degrees F, employ effective means, such as pre-cooling of aggregates and mixing water, using ice or placing at night, as necessary to maintain concrete temperature, as placed, below 90 degrees F.
- H. Cold Weather Placement: Conform to ACI 306.1 - Standard Specification for Cold Weather Concreting, and the following.
 - 1. Remove snow, ice and frost from surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches. Warm reinforcement and embedded items to above 32 degrees F prior to concrete placement.
 - 2. Maintain concrete temperature above 50 degrees F for at least 3 days after placement.

3.04 PUMPING OF CONCRETE

- A. If pumped concrete does not produce satisfactory results, in the judgement of the Engineer, discontinue pumping operations and proceed with the placing of concrete using conventional methods.
- B. Pumping Equipment: Use a 2-cylinder pump designed to operate with only one cylinder if one is not functioning, or have a standby pump on site during pumping.
- C. The minimum hose (conduit) diameter: Comply with ACI 304.2R.
- D. Replace pumping equipment and hoses (conduits) that do not function properly.
- E. Do not use aluminum conduits for conveying concrete.
- F. Field Control: Take samples for slump, air content and test cylinders at the placement (discharge) end of the line.

3.05 CONCRETE PLACEMENT SEQUENCE

- A. Place concrete in a sequence acceptable to the Engineer. To minimize effects of shrinkage, place concrete in units bounded by construction joints shown. Place alternate units so each unit placed has cured at least 7 days for hydraulic structures, or 3 days for other structures, before contiguous unit or units are placed, except do not place corner sections of vertical walls until the 2 adjacent wall panels have cured at least 14 days for hydraulic structures and 7 days for other structures.

- B. Level the concrete surface whenever a run of concrete is stopped. To ensure straight and level joints on the exposed surface of walls, tack a wood strip at least 3/4-inch thick to the forms on these surfaces. Carry concrete about 1/2 inch above the underside of the strip. About one hour after concrete is placed, remove the strip, level irregularities in the edge formed by the strip with a trowel and remove laitance.

3.06 TAMPING AND VIBRATING

- A. Thoroughly settle and compact concrete throughout the entire depth of the layer being consolidated, into a dense, homogeneous mass; fill corners and angles, thoroughly embed reinforcement, eliminate rock pockets and bring only a slight excess of water to the exposed surface of concrete during placement. Use ACI 309R Group 3 immersion-type high-speed power vibrators (8,000 to 12,000 rpm) in sufficient number and with sufficient (at least one) standby units. Use Group 2 vibrators only when accepted by the Engineer for specific locations.
- B. Use care in placing concrete around waterstops. Carefully work concrete by rodding and vibrating to make sure air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, work concrete under waterstops by hand, making sure air and rock pockets have been eliminated. Give concrete surrounding the waterstops additional vibration beyond that used for adjacent concrete placement to assure complete embedment of waterstops in concrete.
- C. Concrete in Walls: Internally vibrate, ram, stir, or work with suitable appliances, tamping bars, shovels or forked tools until concrete completely fills forms or excavations and closes snugly against all surfaces. Do not place subsequent layers of concrete until previously-placed layers have been so worked. Provide vibrators in sufficient numbers, with standby units as required, to accomplish the results specified within 15 minutes after concrete of specified consistency is placed in the forms. Keep vibrating heads from contact with form surfaces. Take care not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.07 PLACING MASS CONCRETE

- A. Observe the following additional restrictions when placing mass concrete.
 - 1. Use specified superplasticizer.
 - 2. Maximum temperature of concrete when deposited: 70 degrees F.
 - 3. Place in lifts approximately 18 inches thick. Extend vibrator heads into previously-placed layer.

3.08 REPAIRING SURFACE DEFECTS AND FINISHING

- A. Conform to Section 03350 - Concrete Finishing.

3.09 CURING

- A. Conform to Section 03390 - Concrete Curing.

3.10 PROTECTION

- A. Protect concrete against damage until final acceptance by the Authority.
- B. Protect fresh concrete from damage due to rain, hail, sleet or snow. Provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring.
- C. Do not backfill around concrete structures or subject them to design loadings until all components of the structure needed to resist the loading are complete and have reached the specified 28-day compressive strength, except as authorized otherwise by the Engineer.

END OF SECTION

Section 03315

CONCRETE FOR UTILITY CONSTRUCTION

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Cast-in-place concrete work for utility construction or rehabilitation, such as slabs on grade, small vaults, site-cast bases for precast units, and in-place liners for manhole rehabilitation.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for concrete for utility construction under this Section. Include cost in applicable utility structure.
 - 2. Extra Class "A" Concrete with or without Forms will be paid on a cubic yard basis if approved by Engineer.
 - 3. Extra Grade 60 Reinforcing Steel in Place will be paid on a per pound basis if approved by Engineer
 - 4. Obtain services of and pay for certified testing laboratory to prepare design mixes.
 - 5. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
- C. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
- D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

- E. ACI 308 - Standard Practice for Curing Concrete.
- F. ACI 309R - Guide for Consolidation of Concrete.
- G. ACI 311 - Guide for Concrete Plant Inspection and Field Testing of Ready-Mix Concrete.
- H. ACI 315 - Details and Detailing of Concrete Reinforcement.
- I. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary.
- J. ACI 544 - Guide for Specifying, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete.
- K. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- L. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- M. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- N. ASTM A 767 - Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
- O. ASTM A 775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
- P. ASTM A 820 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.
- Q. ASTM A 884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- R. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- S. ASTM C 33 - Standard Specification for Concrete Aggregates.
- T. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- U. ASTM C 42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

- V. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- W. ASTM C 138 - Standard Test Method for Unit Weight Yield and Air Content (Gravimetric) of Concrete.
- X. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- Y. ASTM C 150 - Standard Specification for Portland Cement.
- Z. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
- AA. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method..
- AB. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- AC. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- AD. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.
- AE. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- AF. ASTM C 595 - Standard Specification for Blended Hydraulic Cements.
- AG. ASTM C 685 - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
- AH. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
- AI. ASTM C 1077 - Standard Practice for Laboratory Testing of Concrete and Concrete Aggregate for Use in Construction and Criteria for Laboratory Evaluation.
- AJ. CRSI MSP-1 - Manual of Standard Practice.
- AK. CRSI - Placing Reinforcing Bars.
- AL. Federal Specification SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints
- AM. NRMCA - Concrete Plant Standards.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed mix design and test data for each type and strength of concrete in Work.
- C. Submit laboratory reports prepared by independent testing laboratory stating that materials used comply with requirements of this Section.
- D. Submit manufacturer's mill certificates for reinforcing steel. Provide specimens for testing when required by Engineer.
- E. Submit certification from concrete supplier that materials and equipment used to produce and deliver concrete comply with this Specification.
- F. When required on Drawings, submit shop drawings showing reinforcement type, quantity, size, length, location, spacing, bending, splicing, support, fabrication details, and other pertinent information.
- G. For waterstops, submit product information sufficient to indicate compliance with this Section, including manufacturer's descriptive literature and specifications.

1.5 HANDLING AND STORAGE

- A. Cement: Store cement off of ground in well-ventilated, weatherproof building.
- B. Aggregate: Prevent mixture of foreign materials with aggregate and preserve gradation of aggregate.
- C. Reinforcing Steel: Store reinforcing steel to protect it from mechanical injury and formation of rust. Protect epoxy-coated steel from damage to coating.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cementitious Material:
 - 1. Portland Cement: ASTM C 150, Type II, unless use of Type III is authorized by Engineer; or ASTM C 595, Type IP. For concrete in contact with sewage use Type II cement.

2. When aggregates are potentially reactive with alkalis in cement, use cement not exceeding 0.6 percent alkali content in form of $\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$.
- B. Water: Clean, free from harmful amounts of oils, acids, alkalis, or other deleterious substances, and meeting requirements of ASTM C 94.
- C. Aggregate:
 1. Coarse Aggregate: ASTM C 33. Unless otherwise indicated, use following ASTM standard sizes: No. 357 or No. 467; No. 57 or No. 67, No. 7. Maximum size: Not larger than 1/5 of narrowest dimension between sides of forms, nor larger than 3/4 of minimum clear spacing between reinforcing bars.
 2. Fine Aggregate: ASTM C 33.
 3. Determine potential reactivity of fine and coarse aggregate in accordance with Appendix to ASTM C 33.
- D. Air Entraining Admixtures: ASTM C 260.
- E. Chemical Admixtures:
 1. Water Reducers: ASTM C 494, Type A.
 2. Water Reducing Retarders: ASTM 494, Type D.
 3. High Range Water Reducers (Superplasticizers): ASTM C 494, Types F and G.
- F. Prohibited Admixtures: Admixtures containing calcium chloride, thiocyanate, or materials that contribute free chloride ions in excess of 0.1 percent by weight of cement.
- G. Reinforcing Steel:
 1. Use new billet steel bars conforming to ASTM A 615, ASTM A 767, or ASTM A 775, grade 60, as shown on Drawings. Use deformed bars except where smooth bars are specified. When placed in work, keep steel free of dirt, scale, loose or flaky rust, paint, oil or other harmful materials.
 2. Where shown, use welded wire fabric with wire conforming to ASTM A 185 or ASTM A 884. Supply gauge and spacing shown, with longitudinal and transverse wires electrically welded together at points of intersection with welds strong enough not to be broken during handling or placing.

3. Wire: ASTM A 82. Use 16 1/2 gauge minimum for tie wire, unless otherwise indicated.

H. Fiber:

1. Fibrillated Polypropylene Fiber:
 - a. Addition Rate: 1.5 pounds of fiber per cubic yard of concrete.
 - b. Physical Properties:
 1. Material: Polypropylene
 2. Length: 1/2 inch or graded
 3. Specific Gravity: 0.91
 - c. Acceptable Manufacturer: W. R. Grace Company, Fibermesh, or approved equal.
2. Steel Fiber: Comply with applicable provisions of ACI 544 and ASTM A 820.
 - a. Ratio: 50 to 200 pounds of fiber per cubic yard of concrete.
 - b. Physical Properties
 1. Material: Steel
 2. Aspect Ratio (for fiber lengths of 0.5 to 2.5 inch, length divided by diameter or equivalent diameter): 30:1 to 100:1
 3. Specific Gravity: 7.8
 4. Tensile Strength: 40-400 ksi.
 5. Young's Modulus: 29,000 ksi
 6. Minimum Average Tensile Strength: 50,000 psi
 7. Bending Requirements: Withstand bending around 0.125-inch diameter mandrel to angle of 90 degrees, at temperatures not less than 60 degrees F, without breaking

I. Curing Compounds: Type 2 white-pigmented liquid membrane-forming

compounds conforming to ASTM C 309.

2.2 FORM WORK MATERIALS

- A. Lumber and Plywood: Seasoned and of good quality, free from loose or unsound knots, knot holes, twists, shakes, decay and other imperfections which would affect strength or impair finished surface of concrete. Use S4S lumber for facing or sheathing. Forms for bottoms of caps: At least 2 inch (nominal) lumber or 3/4 inch form plywood backed adequately to prevent misalignment. For general use, provide lumber of 1-inch nominal thickness or form plywood of approved thickness.
- B. Form work for Exposed Concrete Indicated to Receive Rubbed Finish: Form or form-lining surfaces free of irregularities; plywood of 1/4 inch minimum thickness, preferably oiled at mill.
- C. Chamfer Strips and Similar Moldings: Redwood, cypress, or pine that will not split when nailed and which can be maintained to true line. Use mill-cut molding dressed on all faces.
- D. Form Ties: Metal or fiberglass of approved type with tie holes not larger than 7/8 inch in diameter. Do not use wire ties or snap ties.
- E. Metal Forms: Clean and in good condition, free from dents and rust, grease, or other foreign materials that tend to disfigure or discolor concrete in gauge and condition capable of supporting concrete and construction loads without significant distortion. Countersink bolt and rivet heads on facing sides. Use only metal forms which present smooth surface and which line up properly.

2.3 PRODUCTION METHODS

- A. Use either ready-mixed concrete conforming to requirements of ASTM C 94, or concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685.

2.4 MEASUREMENT OF MATERIALS

- A. Measure dry materials by weight, except volumetric proportioning may be used when concrete is batched and mixed in accordance with ASTM C 685.
- B. Measure water and liquid admixtures by volume.

2.5 DESIGN MIX

- A. Use design mixes prepared by certified testing laboratory in accordance with ASTM C 1077 and conforming to requirements of this section.

- B. Proportion concrete materials based on ACI 211.1 to comply with durability and strength requirements of ACI 318, Chapters 4 and 5, and this specification. Prepare mix design of Class A concrete so minimum cementitious content is 611 pounds per cubic yard. Submit concrete mix designs to Engineer for review.
- C. Proportioning on basis of field experience or trial mixtures in accordance with requirements at Section 5.3 of ACI 318 may be used, when approved by Engineer.

D. Classification

Class	Type	Minimum Compressive Strength (Lbs/ Sq. In.)		Maximum W/C Ratio	Air Content (Percent)	Consistency Range in Slump (Inches)
		7-Day	28- Day			
A	Structural	3600	4500	0.45	4+ ₁	2 to 4*
B	Pipe Block Fill, Thrust Block	----	1500	----	4+ ₁	5 to 7
*When ASTM C 494, Type F or Type G admixture is used to increase workability, this range may be 6 to 9.						

- E. Add steel or polypropylene fibers only when called for on Drawings or in another section of these Specifications.
- F. Determine air content in accordance with ASTM C 138, ASTM C 173 or ASTM C 231.
- G. Use of Concrete Classes: Use classes of concrete as indicated on Drawings and other Specifications. Use Class B for unreinforced concrete used for plugging pipes, seal slabs, thrust blocks, trench dams, tunnel inverts and concrete fill unless indicated otherwise. Use Class A for all other applications.

2.6 PVC WATERSTOPS

- A. Extrude from virgin polyvinyl chloride elastomer. Use no reclaimed or scrap material. Submit waterstop manufacturer's current test reports and manufacturer's written certification that material furnished meets or exceeds Corps of Engineers Specification CRD-C572 and other specified requirements.
- B. Flat Strip and Center-Bulb Waterstops:

1. Thickness: not less than 3/8 inch
2. Acceptable Manufacturers:
 - a. Kirkhill Rubber Co., Brea, California
 - b. Water Seals, Inc., Chicago, Illinois
 - c. Progress Unlimited, Inc., New York, New York
 - d. Greenstreak Plastic Products Co., St. Louis, Missouri
 - e. Approved equal.

2.7 RESILIENT WATERSTOP

- A. Resilient Waterstop: Where shown on Drawings; either bentonite- or adhesive-type material.
- B. Bentonite Waterstop:
 1. Material: 75 percent bentonite, mixed with butyl rubber-hydrocarbon containing less than 1.0 percent volatile matter, and free of asbestos fibers or asphaltics.
 2. Manufacturer's rated temperature ranges: For application, 5 to 125 degrees F; in service, -40 to 212 degrees F.
 3. Cross-sectional dimensions, unexpanded waterstop: 1 inch by 3/4 inch
 4. Provide with adhesive backing capable of producing excellent adhesion to concrete surfaces.
- C. Adhesive Waterstop:
 1. Preformed plastic adhesive waterstop at least 2 inches in diameter.
 2. Meets or exceeds requirements of Federal Specification SS-S-210A.
 3. Supplied wrapped completely by 2 part protective paper.
 4. Submit independent laboratory tests verifying that material seals joints in concrete against leakage when subjected to minimum of 30 psi water pressure for at least 72 hours.
 5. Provide primer, to be used on hardened concrete surfaces, from same

manufacturer who supplies waterstop material.

6. Acceptable Manufacturer: Synko-Flex Preformed Plastic Adhesive Waterstop, Synko- Flex Products, Inc.; or approved equal.

PART 3 EXECUTION

3.1 FORMS AND SHORING

- A. Provide mortar-tight forms sufficient in strength to prevent bulging between supports. Set and maintain forms to lines designated such that finished dimensions of structures are within tolerances specified in ACI 117. Construct forms to permit removal without damage to concrete. Forms may be given slight draft to permit ease of removal. Provide adequate clean out openings. Before placing concrete, remove extraneous matter from within forms.
- B. Install rigid shoring having no excessive settlement or deformation. Use sound timber in shoring centering. Shim to adjust and tighten shoring with hardwood timber wedges.
- C. Design Loads for Horizontal Surfaces of Forms and Shoring: Minimum fluid pressure, 175 pounds per cubic foot; live load, 50 pounds per square foot. Maximum unit stresses: 125 percent of allowable stresses used for form materials and for design of support structures.
- D. Back form work with sufficient number of studs and wales to prevent deflection.
- E. Re-oil or lacquer liner on job before using. Facing may be constructed of 3/4 inch plywood made with waterproof adhesive backed by adequate studs and wales. In such cases, form lining will not be required.
- F. Unless otherwise indicated, form outside corners and edges with triangular 3/4 inch chamfer strips (measured on sides).
- G. Remove metal form ties to depth of at least 3/4 inch from surface of concrete. Do not burn off ties. Do not use pipe spreaders. Remove spreaders which are separate from forms as concrete is being placed.
- H. Treat facing of forms with approved form coating before concrete is placed. When directed by Engineer, treat both sides of face forms with coating. Apply coating before reinforcement is placed. Immediately before concrete is placed, wet surface of forms which will come in contact with concrete.

3.2 PLACING REINFORCEMENT

- A. Place reinforcing steel accurately in accordance with approved Drawings. Secure steel adequately in position in forms to prevent misalignment. Maintain reinforcing steel in place using approved concrete and hot-dip galvanized metal chairs and spacers. Place reinforcing steel in accordance with CRSI Publication "Placing Reinforcing Bars." Request inspection of reinforcing steel by Engineer and obtain acceptance before concrete is placed.
- B. Minimum spacing center-to-center of parallel bars: 2 1/2 times nominal bar diameter. Minimum cover measured from surface of concrete to face of reinforcing bar unless shown otherwise on Drawings: 3 inches for surfaces cast against soil or subgrade, 2 inches for other surfaces.
- C. Detail bars in accordance with ACI 315. Fabricate reinforcing steel in accordance with CRSI Publication MSP-1, "Manual of Standard Practice." Bend reinforcing steel to required shape while steel is cold. Excessive irregularities in bending will be cause for rejection.
- D. Do not splice bars without written approval of Engineer. Approved bar bending schedules or placing drawings constitute written approval. Splice and development length of bars shall conform to ACI 318, Chapters 7 and 12, and as shown on Drawings. Stagger splices or locate at points of low tensile stress.

3.3 EMBEDDED ITEMS

- A. Install conduit and piping as shown on Drawings. Accurately locate and securely fasten conduit, piping, and other embedded items in forms.
- B. Install waterstops as specified in other sections and according to manufacturer's instructions. Securely position waterstops at joints as indicated on Drawings. Protect waterstops from damage or displacement during concrete placing operations.

3.4 BATCHING, MIXING AND DELIVERY OF CONCRETE

- A. Measure, batch, mix, and deliver ready-mixed concrete in accordance with ASTM C 94, Sections 8 through 11. Produce ready-mixed concrete using automatic batching system as described in NRMCA Concrete Plant Standards, Part 2 - Plant Control Systems.
- B. Measure, mix and deliver concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685, Sections 6 through 8.
- C. Maintain concrete workability without segregation of material and excessive bleeding. Obtain approval of Engineer before adjustment and change of mix proportions.

- D. Ready-mixed concrete delivered to site shall be accompanied by batch tickets providing information required by ASTM C 94, Section 16. Concrete produced by continuous mixing shall be accompanied by batch tickets providing information required by ASTM C 685, Section 14.
- E. When adverse weather conditions affect quality of concrete, postpone concrete placement. Do not mix concrete when air temperature is at or below 40 degrees F and falling. Concrete may be mixed when temperature is 35 degrees F and rising. Take temperature readings in shade, away from artificial heat. Protect concrete from temperatures below 32 degrees F until concrete has cured for minimum of 3 days at 70 degrees F or 5 days at 50 degrees F.
- F. Clean, maintain and operate equipment so that it thoroughly mixes material as required.
- G. Hand-mix only when approved by Engineer.

3.5 PLACING CONCRETE

- A. Give sufficient advance notice to Engineer (at least 24 hours prior to commencement of operations) to permit inspection of forms, reinforcing steel, embedded items and other preparations for placing concrete. Place no concrete prior to Engineer's approval.
- B. Schedule concrete placing to permit completion of finishing operations in daylight hours. However, when necessary to continue after daylight hours, light site as required. When rainfall occurs after placing operations are started, provide covering to protect work.
- C. Use troughs, pipes and chutes lined with approved metal or synthetic material in placing concrete so that concrete ingredients are not separated. Keep chutes, troughs and pipes clean and free from coatings of hardened concrete. Allow no aluminum material to be in contact with concrete.
- D. Limit free fall of concrete to 4 feet. Do not deposit large quantities of concrete at one location so that running or working concrete along forms is required. Do not jar forms after concrete has taken initial set; do not place strain on projecting reinforcement or anchor bolts.
- E. Use tremies for placing concrete in walls and similar narrow or restricted locations. Use tremies made in sections, or provide in several lengths, so that outlet may be adjusted to proper height during placing operations.
- F. Place concrete in continuous horizontal layers approximately 12 inches thick. Place each layer while layer below is still plastic.

- G. Compact each layer of concrete with concrete spading implements and mechanical vibrators of approved type and adequate number for size of placement. When immersion vibrators cannot be used, use form vibrators. Apply vibrators to concrete immediately after depositing. Move vibrator vertically through layer of concrete just placed and several inches into plastic layer below. Do not penetrate or disturb layers previously placed which have partially set. Do not use vibrators to aid lateral flow concrete. Closely supervise consolidation to ensure uniform insertion and duration of immersion.
- H. Handling and Placing Concrete: Conform to ACI 302.1R, ACI 304R and ACI 309R.

3.6 WATERSTOPS

- A. Embed waterstops in concrete across joints as shown. Waterstops shall be continuous for extent of joint; make splices necessary to provide continuity in accordance with manufacturer's instructions. Support and protect waterstops during construction operations; repair or replace waterstops damaged during construction.
- B. Install waterstops in concrete on one side of joints, leaving other side exposed until next pour. When waterstop will remain exposed for 2 days or more, shade and protect exposed waterstop from direct rays of sun during entire exposure and until exposed portion of waterstop is embedded in concrete.
- C. Splicing PVC Waterstops:
 - 1. Splice waterstops by heat-sealing adjacent waterstop sections in accordance with manufacturer's printed instructions.
 - 2. Butt end-to-end joints of two identical waterstop sections may be made in forms during placement of waterstop material.
 - 3. Prior to placement in form work, prefabricate waterstop joints involving more than two ends to be joined together, angle cut, alignment change, or joining of two dissimilar waterstop sections, allowing not less than 24 inch long strips of waterstop material beyond joint. Upon inspection and approval by Engineer, install prefabricated waterstop joint assemblies in form work, and butt-weld ends of 24 inch strips to straight- run portions of waterstop in forms.
- D. Setting PVC Waterstops:
 - 1. Correctly position waterstops during installation. Support and anchor waterstops during progress of work to ensure proper embedment in concrete and to prevent folding over of waterstop by concrete placement.

Locate symmetrical halves of waterstops equally between concrete pours at joints, with center axis coincident with joint openings. Thoroughly work concrete in joint vicinity for maximum density and imperviousness.

2. Where waterstop in a vertical wall joint does not connect with any other waterstop, and is not intended to be connected to waterstop in future concrete placement, terminate waterstop 6 inches below top of wall.
- E. Replacement of Defective Field Joints: Replace waterstop field joints showing evidence of misalignment, offset, porosity, cracks, bubbles, inadequate bond or other defects with products and joints complying with Specifications.
- F. Resilient Waterstop:
1. Install resilient waterstop in accordance with manufacturer's instructions and recommendations.
 2. When requested by Engineer, provide technical assistance by manufacturer's representative in field at no additional cost to Authority.
 3. Use resilient waterstop only where complete confinement by concrete is provided; do not use in expansion or contraction joints.
 4. Where resilient waterstop is used in combination with PVC waterstop, lap resilient waterstop over PVC waterstop minimum of 6 inches and place in contact with PVC waterstop. Where crossing PVC at right angles, melt PVC ribs to form smooth joining surface.
 5. At free top of walls without connecting slabs, stop resilient waterstop and grooves (where used) 6 inches from top in vertical wall joints.
 6. Bentonite Waterstop:
 - a. Locate bentonite waterstop as near as possible to center of joint and extend continuous around entire joint. Minimum distance from edge of waterstop to face of member: 5 inches.
 - b. Where thickness of concrete member to be placed on bentonite waterstop is less than 12 inches, place waterstop in grooves at least 3/4 inch deep and 1 1/4 inches wide formed or ground into concrete. Minimum distance from edge of waterstop placed in groove to face of member: 2.5 inches.
 - c. Do not place bentonite waterstop when waterstop material temperature is below 40 degrees F. Waterstop material may be warmed so that it remains above 40 degrees F during placement but

means used to warm it shall in no way harm material or its properties. Do not install waterstop where air temperature falls outside manufacturer's recommended range.

- d. Place bentonite waterstop only on smooth and uniform surfaces; grind concrete smooth when necessary to produce satisfactory substrate, or bond waterstop to irregular surfaces using epoxy grout which completely fills voids and irregularities beneath waterstop material. Prior to installation, wire brush concrete surface to remove laitance and other substances that may interfere with bonding of epoxy.
- e. In addition to adhesive backing provided with waterstop, secure bentonite waterstop in place with concrete nails and washers at 12 inch maximum spacing.

7. Adhesive Waterstop:

- a. With wire brush thoroughly clean concrete surface on which waterstop is to be placed and then coat with primer.
- b. If surface is too rough to allow waterstop to form complete contact, grind to form adequately smooth surface.
- c. Install waterstop with top protective paper left in place. Overlap joints between strips minimum of 1 inch and cover back over with protective paper.
- d. Do not remove protective paper until just before final form work completion. Place concrete immediately. Time that waterstop material is uncovered prior to concrete placement shall be minimized and shall not exceed 24 hours.

3.7 CONSTRUCTION JOINTS

A. Definitions:

- 1. Construction joint: Contact surface between plastic (fresh) concrete and concrete that has attained initial set.
- 2. Monolithic: Manner of concrete placement to reduce or eliminate construction joints; joints other than those indicated on Drawings will not be permitted without written approval of Engineer. Where so approved, make additional construction joints with details equivalent to those indicated for joints in similar locations.

3. Preparation for Construction Joints: Roughen surface of concrete previously placed, leaving some aggregate particles exposed. Remove laitance and loose materials by sandblasting or high-pressure water blasting. Keep surface wet for several hours prior to placing of plastic concrete.

3.8 CURING

- A. Comply with ACI 308. Cure by preventing loss of moisture, rapid temperature change and mechanical injury for period of 7 curing days when Type II or IP cement has been used and for 3 curing days when Type III cement has been used. Start curing as soon as free water has disappeared from concrete surface after placing and finishing. A curing day is any calendar day in which temperature is above 50 degrees F for at least 19 hours. Colder days may be counted when air temperature adjacent to concrete is maintained above 50 degrees F. In continued cold weather, when artificial heat is not provided, removal of forms and shoring may be permitted at end of calendar days equal to twice required number of curing days. However, leave soffit forms and shores in place until concrete has reached specified 28 day strength, unless directed otherwise by Engineer.
- B. Cure formed surfaces not requiring rubbed-finished surface by leaving forms in place for full curing period. Keep wood forms wet during curing period. Add water as needed for other types of forms. Or, at Contractor's option, forms may be removed after 2 days and curing compound applied.
- C. Rubbed Finish:
 1. At formed surfaces requiring rubbed finish, remove forms as soon as practicable without damaging surface.
 2. After rubbed-finish operations are complete, continue curing formed surfaces by using either approved curing/sealing compounds or moist cotton mats until normal curing period is complete.
- D. Unformed Surfaces: Cure by membrane curing compound method.
 1. After concrete has received final finish and surplus water sheen has disappeared, immediately seal surface with uniform coating of approved curing compound, applied at rate of coverage recommended by manufacturer or as directed by Engineer. Do not apply less than 1 gallon per 180 square feet of area. Provide satisfactory means to properly control and check rate of application of compound.
 2. Thoroughly agitate compound during use and apply by means of approved mechanical power pressure sprayers equipped with atomizing nozzles. For application on small miscellaneous items, hand-powered spray equipment

may be used. Prevent loss of compound between nozzle and concrete surface during spraying operations.

3. Do not apply compound to dry surface. When concrete surface has become dry, thoroughly moisten surface immediately prior to application. At locations where coating shows discontinuities, pinholes or other defects, or when rain falls on newly coated surface before film has dried sufficiently to resist damage, apply additional coat of compound at specified rate of coverage.

3.9 REMOVAL OF FORMS AND SHORING

- A. Remove forms from surfaces requiring rubbing only as rapidly as rubbing operation progresses. Remove forms from vertical surfaces not requiring rubbed-finish when concrete has aged for required number of curing days. When curing compound is used, do not remove forms before 2 days after concrete placement.
- B. Leave soffit forms and shores in place until concrete has reached specified 28-day strength, unless directed otherwise by Engineer.

3.10 DEFECTIVE WORK

- A. Immediately repair defective work discovered after forms have been removed. When concrete surface is bulged, uneven, or shows excess honeycombing or form marks which cannot be repaired satisfactorily through patching, remove and replace entire section.

3.11 FINISHING

- A. Patch honeycomb, minor defects and form tie holes in concrete surfaces with cement mortar mixed one part cement to two parts fine aggregate. Repair defects by cutting out unsatisfactory material and replacing with new concrete, securely keyed and bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. Use stiff mixture and thoroughly tamp into place. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off mortar flush with surface.
- B. Apply rubbed finish to exposed surfaces of formed concrete structures as noted on Drawings. After pointing has set sufficiently, wet surface with brush and perform first surface rubbing with No. 16 carborundum stone, or approved equal. Rub sufficiently to bring surface to paste, to remove form marks and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Spread or brush material, which has been ground to paste, uniformly over surface and allow to reset. In preparation for final acceptance, clean surfaces and perform final finish rubbing with No. 30 carborundum stone or approved equal. After rubbing, allow paste on surface to reset; then wash surface

with clean water. Leave structure with clean, neat and uniform-appearing finish.

- C. Apply wood float finish to concrete slabs.

3.12 FIELD QUALITY CONTROL

- A. Testing shall be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Unless otherwise directed by Engineer, following minimum testing of concrete is required. Testing shall be performed by qualified individuals employed by approved independent testing agency, and conform to requirements of ASTM C 1077.
 - 1. Take concrete samples in accordance with ASTM C 172.
 - 2. Make one set of four compression test specimens for each mix design at least once per day and for each 150 cubic yards or fraction thereof. Make, cure and test specimens in accordance with ASTM C 31 and ASTM C 39.
 - 3. When taking compression test specimens, test each sample for slump according to ASTM C 143, for temperature according to ASTM C 1064, for air content according to ASTM C 231, and for unit weight according to ASTM C 138.
 - 4. Inspect, sample and test concrete in accordance with ASTM C 94, Section 13, 14, and 15, and ACI 311-5R.
- C. Test Cores: Conform to ASTM C 42.
- D. Testing High Early Strength Concrete: When Type III cement is used in concrete, specified 7 day and 28 day compressive strengths shall be applicable at 3 and 7 days, respectively.
- E. If 7-day or 3-day test strengths (as applicable for type of cement being used) fail to meet established strength requirements, extended curing or resumed curing on those portions of structure represented by test specimens may be required. When additional curing fails to produce required strength, strengthening or replacement of portions of structure which fail to develop required strength may be required by Engineer, at no additional cost to Authority

3.13 PROTECTION

- A. Protect concrete against damage until final acceptance by Authority.
- B. Protect fresh concrete from damage due to rain, hail, sleet, or snow. Provide

protection while concrete is still plastic, and whenever precipitation is imminent or occurring.

- C. Do not backfill around concrete structures or subject them to design loadings until components of structure needed to resist loading are complete and have reached specified 28 day compressive strength, except as authorized otherwise by Engineer.

END OF SECTION

Section 03350
CONCRETE FINISHING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Repairing surface defects.
- B. Finishing concrete surfaces including both formed and unformed surfaces.
- C. Sealing concrete surfaces.
- D. Installation of concrete fill and installation of concrete topping in bottoms of clarifiers and thickeners.

1.02 UNIT PRICES

- A. No separate payment will be made for concrete finishing under this Section. Include payment in unit price for structural concrete.

1.03 REFERENCES

- A. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.
- B. ASTM C 881 - Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- C. ASTM C 1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
- D. ASTM D 4587 - Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light-and Water-Exposure Apparatus.
- E. ASTM E 1155 - Standard Test Method for Determining Floor Flatness and Levelness Using the F Number System.

1.04 SUBMITTALS

- A. Conform to Section 01330 - Submittal Procedures
- B. Submit manufacturer's technical literature on the following products proposed for use. Include manufacturer's installation and application instructions and, where specified, manufacturer's certification of conformance to requirements and suitability for use in the applications indicated.
 - 1. Floor hardener.
 - 2. Sealer.
 - 3. Epoxy floor topping.
 - 4. Epoxy penetrating sealer.
 - 5. Latex bonding agent.
 - 6. Epoxy adhesive.

7. Abrasive aggregate.
8. Evaporation retardant.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Sealer/Dustproofer (VOC Compliant): Water-based acrylic sealer; non-yellowing under ultraviolet light after 200-hour test in accordance with ASTM D 4587. Conform to local, state and federal solvent emission requirements.
- B. Epoxy Floor Topping: Two-component epoxy resin meeting ASTM C 881 Type III, resistant to wear, staining and chemical attack, blended with granite, sand, trap rock or quartz aggregate, trowel-applied over concrete floor. Topping thickness, 1/8 inch; color, gray.
- C. Abrasive Aggregate for Nonslip Finish: Fused aluminum oxide grit, or crushed emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Material shall be factory graded, packaged, rustproof and nonglazing, and unaffected by freezing, moisture and cleaning materials.
- D. Epoxy Penetrating Sealer: Low-viscosity, two-component epoxy system designed to give maximum penetration into concrete surfaces. Sealer shall completely seal concrete surfaces from penetration of water, oil and chemicals; prevent dusting and deterioration of concrete surfaces caused by heavy traffic; and be capable of adhering to floor surfaces subject to hydrostatic pressure from below. Color, transparent amber or gray; surface, nonslip.
- E. Latex Bonding Agent: Non-redispersable latex base liquid conforming to ASTM C 1059. When used in water and wastewater treatment structures, bonding agent shall be suitable for use under continuously submerged conditions. Conformance and suitability certification by manufacturer is required.
- F. Bonding Grout: Prepare bonding grout by mixing approximately one part cement to one part fine sand meeting ASTM C 144 but with 100 percent passing No. 30 mesh sieve. Mix with water to consistency of thick cream. At Contractor's option, a commercially-prepared bonding agent used in accordance with manufacturer's recommendations and instructions may be used. When used in water and wastewater treatment structures, bonding agent shall be suitable for use under continuously submerged conditions. Conformance and suitability certification by manufacturer is required. Submit manufacturer's technical information on proposed bonding agent.
- G. Patching Mortar:
 1. Make patching mortar of same materials and of approximately same proportions as concrete, except omit coarse aggregate. Substitute white Portland cement for part of gray Portland cement on exposed concrete in order to match color of surrounding concrete. Determine color by making trial patch. Use minimum amount of mixing water required for handling and placing. Mix patching mortar in advance and allow to stand. Mix frequently

with trowel until it has reached stiffest consistency that will permit placing. Do not add water.

2. Proprietary compounds for adhesion or specially formulated cementitious repair mortars may be used in lieu of or in addition to foregoing patching materials provided that properties of bond and compressive strength meet or exceed the foregoing and color of surrounding concrete can be matched where required. Use such compounds according to manufacturer's recommendations. When used in water and wastewater treatment structures, material shall be suitable for use under continuously submerged conditions. Conformance and suitability certification by manufacturer is required.
- H. Epoxy Adhesive: Two-component, 100 percent solids, 100 percent reactive compound developing 100 percent of strength of concrete, suitable for use on dry or damp surfaces. Epoxy used to inject cracks and as a binder in epoxy mortar shall meet ASTM C 881, Type VI. Epoxy used as a bonding agent for fresh concrete shall meet ASTM C 881, Type V.
- I. Non-shrink Grout: See Section 03600 - Structural Grout.
- J. Spray-Applied Coating: Acceptable products are Thoro System Products "Thorseal Plaster Mix" or equal. Color: Gray.
- K. Concrete Topping: Class H concrete with 3/8-inch maximum coarse aggregate size, as specified in Section 03310 - Structural Concrete.
- L. Concrete Fill: Class H concrete with 3/8-inch maximum coarse aggregate size, (Class C where fill thickness exceeds 3 inches throughout a placement), as specified in Section 03310 - Structural Concrete.
- M. Evaporation Retardant: Confilm, manufactured by Master Builders; Eucobar, manufactured by Euclid Chemical Company; or equal.

PART 3 EXECUTION

3.01 AGGREGATE CONCEALMENT

- A. Unless indicated otherwise on Drawings or approved by Project Manager, all surfaces to be finished shall be free of exposed aggregate.

3.02 REPAIRING SURFACE DEFECTS

- A. Defective Areas: Repair immediately after removal of forms. Remove honeycombed and other defective concrete down to sound concrete but in no case to a depth less than one inch. Make edges of cuts perpendicular to concrete surface. Thoroughly work bonding grout into the surface with a brush as that the entire surface is covered. Alternatively, a proprietary bonding agent may be used. Use bonding agent in accordance with manufacturer's instructions. While bonding coat is still tacky, apply premixed patching mortar. Thoroughly consolidate mortar into place and strike off to leave patch slightly higher than surrounding surface. To permit initial shrinkage, leave undisturbed for at least 1 hour before final finishing. Keep patched area damp for 7 days. Alternatively, a proprietary cementitious repair mortar may be used and

placed in accordance with manufacturer's instructions. Do not use metal tools in finishing patches in formed walls which will be exposed.

- B. Tie Holes: Patch holes immediately after removal of forms. After cleaning and roughening with a wire brush on a rotary drill, thoroughly dampen tie hole and fill solid with patching mortar. Taper tie holes shall have the plug, specified in Section 03100 - Concrete Formwork, driven into the hole to the center of the wall before grouting. Completely fill taper tie holes with patching mortar except that non-shrink grout shall be used for all walls in contact with soil or liquid. On wall faces exposed to view, fill the outer 2 inches of the taper tie hole with patching mortar blended to match adjacent concrete.
- C. Cracks: Repair cracks in excess of 0.01 inch by pressure injection of moisture-insensitive epoxy-resin system. Submit proposed material and method of repair for approval prior to making repairs.
- D. Structural Repair: When required, make structural repairs after prior approval of Project Manager as to method and procedure, using specified epoxy adhesive or approved epoxy mortar.

3.03 FINISHING OF FORMED SURFACES

- A. Unfinished Surfaces: Finish is not required on surfaces concealed from view in completed structure by earth, ceilings or similar cover, unless indicated otherwise on Drawings.
- B. Rough Form Finish:
 - 1. No form facing material is required on rough form finish surfaces.
 - 2. Patch tie holes and defects. Chip off fins exceeding 1/4 inch in height.
 - 3. Rough form finish may be used on concrete surfaces which will be concealed from view by earth in completed structure, except concealed surfaces required to have smooth form finish, as shown on Drawings.
- C. Smooth Form Finish:
 - 1. Form facing shall produce smooth, hard, uniform texture on concrete. Use plywood or fiberboard linings or forms in as large sheets as practicable, and with smooth, even edges and close joints.
 - 2. Patch tie holes and defects. Rub fins and joint marks with wooden blocks to leave smooth, unmarred finished surface.
 - 3. Provide smooth form finish on the wet face of formed surfaces of water-holding structures, and of other formed surfaces not concealed from view by earth in completed structure, except where otherwise indicated on Drawings. Walls that will be exposed after future construction, at locations indicated on Drawings, shall have smooth form finish. Smooth form finish on exterior face of exterior walls shall extend 2 feet below final top of ground elevation. Exterior face of all perimeter grade beams shall have smooth form finish for full depth of grade beam.

D. Rubbed Finish:

1. Use plywood or fiberboard linings or forms in as large sheets as practicable, and with smooth, even edges and close joints.
2. Remove forms as soon as practicable, repair defects, wet surfaces, and rub with No. 16 carborundum stone or similar abrasive. Continue rubbing sufficiently to bring surface paste, remove form marks and fins, and produce smooth, dense surface of uniform color and texture. Do not use cement paste other than that drawn from concrete itself. Spread paste uniformly over surface with brush. Allow paste to reset, then wash surface with clean water.
3. Use rubbed finish at locations indicated on Drawings, except where rubbed finish is indicated for a wall which will be containing a liquid, use spray-applied coating.

E. Spray-applied Coating: At Contractor's option, in lieu of rubbed finish, spray-applied coating may be applied after defects have been repaired and fins removed. Remove form oil, curing compound and other foreign matter that would prevent bonding of coating. Apply coating in uniform texture and color in accordance with coating manufacturer's instructions.

F. Related Unformed Surfaces: Tops of piers, walls, bent caps, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed. Float unformed surfaces to texture reasonably consistent with that of formed surfaces. Continue final treatment on formed surfaces uniformly across unformed surfaces.

3.04 HOT WEATHER FINISHING

A. When hot weather conditions exist, as defined by Section 03310 - Structural Concrete and as judged by the Project Manager, apply evaporation retardant to the surfaces of slabs, topping and concrete fill placements immediately after each step in the finishing process has been completed.

3.05 FINISHING SLABS AND SIMILAR FLAT SURFACES TO CLASS A, B, AND C TOLERANCES

A. Apply Class A, B, and C finishes at locations indicated on Drawings.

B. Shaping to Contour: Use strike-off templates or approved compacting-type screeds riding on screed strips or edge forms to bring concrete surface to proper contour. See Section 03100 - Concrete Formwork for edge forms and screeds.

C. Consolidation and Leveling: Concrete to be consolidated shall be as stiff as practicable Thoroughly consolidate concrete in slabs and use internal vibration in beams and girders of framed slabs and along bulkheads of slabs on grade. Consolidate and level slabs and floors with vibrating bridge screeds, roller pipe screeds or other approved means. After consolidation and leveling, do not permit manipulation of surfaces prior to finishing operations.

- D. Tolerances for Finished Surfaces: Check tolerances by placing straightedge of specified length anywhere on slab. Gap between slab and straightedge shall not exceed tolerance listed for specified class.

<u>Class</u>	<u>Straightedge Length in Feet</u>	<u>Tolerance in Inches</u>
A	10	1/8
B	10	1/4
C	2	1/4

- E. Raked Finish: After concrete has been placed, struck off, consolidated and leveled to Class C tolerance, roughen surface before final set. Roughen with stiff brushes or rakes to depth of approximately 1/4 inch. Notify Project Manager prior to placing concrete requiring initial raked surface finish so that acceptable raked finish standard may be established for project. Protect raked, base-slab finish from contamination until time of topping. Provide raked finish for following:

1. Surfaces to receive bonded concrete topping or fill.
2. Steep ramps, as noted on Drawings.
3. Additional locations as noted on Drawings.

- F. Float Finish:

1. After concrete has been placed, struck off, consolidated and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared, or when mix has stiffened sufficiently to permit proper operation of power-driven float. Consolidate surface with power-driven floats. Use hand floating with wood or cork-faced floats in locations inaccessible to power-driven machine and on small, isolated slabs.
2. After initial floating, re-check tolerance of surface with 10-foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots to Class B tolerance. Immediately re-float slab to a uniform, smooth, granular texture.
3. Provide float finish at locations not otherwise specified and not otherwise indicated on Drawings.

- G. Trowel Finish:

1. Apply float finish as previously specified. After power floating, use power trowel to produce smooth surface which is relatively free of defects but which may still contain some trowel marks. Do additional troweling by hand after surface has hardened sufficiently. Do final troweling when ringing sound is produced as trowel is moved over surface. Thoroughly consolidate surface by hand troweling operations.
2. Produce finished surface free of trowel marks, uniform in texture and appearance and conforming to Class A tolerance. On surfaces intended to support floor coverings, remove defects which might show through covering by grinding.

3. Provide trowel finish for floors which will receive floor covering and additional locations indicated on Drawings.
- H. Broom or Belt Finish:
 1. Apply float finish as previously specified. Immediately after completing floated finish, draw broom or burlap belt across surface to give coarse transverse scored texture.
 2. Provide broom or belt finish at locations indicated on Drawings.
- 3.06 FINISHING SLABS AND SIMILAR FLAT SURFACES TO "F-NUMBER SYSTEM" FINISH
 - A. Shaping to Contour: Use strike-off templates or approved compacting-type screeds riding on screed strips or edge forms to bring concrete surface to proper contour. Edge forms and screeds: Conform to Section 03100 - Concrete Formwork.
 - B. Consolidation and Leveling: Concrete to be consolidated shall be as dry as practicable. Thoroughly consolidate concrete in slabs and use internal vibration in beams and girders of framed slabs and along bulkheads of slabs on grade. Consolidate and level slabs and floors with vibrating bridge screeds, roller pipe screeds or other approved means. After consolidation and leveling, do not manipulate surfaces prior to finishing operations.
 - C. Tolerances for Finished Surfaces: Independent testing laboratory will check floor flatness and levelness in accordance with Paragraph 3.12, Field Quality Control.
 - D. Float Finish:
 1. After concrete has been placed, struck off, consolidated and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared, or when mix has stiffened sufficiently to permit proper operation of power-driven float. Consolidate surface with power-driven floats. Use hand floating with wood or cork-faced floats in locations inaccessible to power-driven machine and on small, isolated slabs.
 2. Check tolerance of surface after initial floating with a 10-foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots. Immediately refloat slab to uniform, smooth, granular texture to F_F20/F_L17 tolerance, unless shown otherwise on Drawings.
 3. Provide "F-Number System" float finish at locations indicated on Drawings.
 - E. Trowel Finish:
 1. Apply float finish as previously specified. After power floating, use power trowel to produce smooth surface which is relatively free of defects but which may still contain some trowel marks. Do additional trowelings by hand after surface has hardened sufficiently. Do final troweling when ringing sound is produced as trowel is moved over surface. Thoroughly consolidate surface by hand troweling operations.

2. Produce finished surface free of trowel marks, uniform in texture and appearance and conforming to an F_F25/F_L20 tolerance for slabs on grade and F_F25/F_L17 for elevated slabs, unless shown otherwise on Drawings. On surfaces intended to support floor coverings, remove defects, which might show through covering, by grinding.
 3. Provide "F-Number System" trowel finish at locations indicated on Drawings.
- 3.07 BONDED CONCRETE TOPPING AND FILL
- A. Surface Preparation:
 1. Protect raked, base-slab finish from contamination until time of topping. Mechanically remove oil, grease, asphalt, paint, clay stains or other contaminants, leaving clean surface.
 2. Prior to placement of topping or fill, thoroughly dampen roughened slab surface and leave free of standing water. Immediately before topping or fill is placed, scrub coat of bonding grout into surface. Do not allow grout to set or dry before topping or fill is placed.
 - B. Concrete Fill:
 1. Where concrete fill intersects a wall surface at an angle steeper than 45 degrees from vertical, provide a 1.5-inch deep keyway in the wall at the point of intersection; size keyway so that no portion of the concrete fill is less than 1.5 inches thick. Form keyway in new walls; create by saw cutting the top and bottom lines and chipping in existing walls.
 2. Apply wood float finish to surfaces of concrete fill.
 3. Provide concrete fill at locations shown on Drawings.
 - C. Bonded Concrete Topping in Bottom of Clarifiers and Thickeners:
 1. Minimum thickness of concrete topping: 1 inch. Maximum thickness when swept in by clarifier and thickener equipment: 3 inches.
 2. Compact topping and fill by rolling or tamping, bring to established grade, and float. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement. Coat surface with evaporation retardant as needed between finishing operations to prevent plastic shrinkage cracks.
 3. Screed topping to true surface using installed equipment. Protect equipment from damage during sweeping-in process. Perform sweeping-in process under supervision of equipment manufacturer's factory representative. After topping has been screeded, apply wood float finish. During finishing, do not apply water, dry cement or mixture of dry cement and sand to the surface.
 4. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the Project Manager, fill the tank with sufficient water to cover the entire floor for 14 days.

5. Provide bonded concrete topping in bottom of all clarifiers and thickeners.

3.08 EPOXY PENETRATING SEALER

- A. Surfaces to receive epoxy penetrating sealer: Apply wood float finish. Clean surface and apply sealer in compliance with manufacturer's instructions.
- B. Rooms with concrete curbs or bases: Continue application of floor coating on curb or base to its juncture with masonry wall. Rooms with solid concrete walls or wainscots: Apply minimum 2-inch-high coverage of floor coating on vertical surface.
- C. Mask walls, doors, frames and similar surface to prevent floor coating contact.
- D. When coving floor coating up vertical concrete walls, curbs, bases or wainscots, use masking tape or other suitable material to keep a neat level edge at top of cove.
- E. Provide epoxy penetrating sealer at locations indicated on Drawings.

3.09 EPOXY FLOOR TOPPING

- A. Surfaces to receive epoxy floor topping: Apply wood float finish unless recommended otherwise by epoxy floor topping manufacturer. Clean surface and apply epoxy floor topping in compliance with manufacturer's recommendations and instructions. Thickness of topping: 1/8 inch.
- B. Rooms with concrete curbs or bases: Continue application of floor coating on curb or base to its juncture with masonry wall. Rooms with solid concrete walls or wainscots: apply 2-inch-high coverage of floor coating on vertical surface.
- C. Mask walls, doors, frames and similar surfaces to prevent floor coating contact.
- D. When coving floor coating up vertical concrete walls, curbs, bases or wainscots, use masking tape or other suitable material to keep a neat level edge at top of cove.
- E. Finished surface shall be free of trowel marks and dimples.
- F. Provide epoxy floor topping at locations indicated on Drawings.

3.10 SEALER/DUSTPROOFER

- A. Where sealer or sealer/dustproofers is indicated on Drawings, just prior to completion of construction, apply coat of specified clear sealer/dustproofing compound to exposed interior concrete floors in accordance with manufacturer's instructions.

3.11 NONSLIP FINISH

- A. Apply float finish as specified. Apply two-thirds of required abrasive aggregate by method that ensures even coverage without segregation and re-float. Apply remainder of abrasive aggregate at right angles to first application, using heavier application of aggregate in areas not sufficiently covered by first application. Re-float after second application of aggregate and complete operations with troweled finish. Perform finishing operations in a manner that will allow the abrasive aggregate to be exposed and not covered with cement paste.
- B. Provide nonslip finish at locations indicated on Drawings.

3.12 FIELD QUALITY CONTROL

- A. Flatness and levelness of slabs and similar flat surfaces that are indicated on Drawings to receive "F-Number System" finish will be checked by independent testing laboratory employed by Authority in accordance with Section 01460 - Testing Laboratory Services.
 - B. Tolerances for "F-Number System" finished surfaces:
 - 1. Floor tolerance shall be determined in accordance with ASTM E 1155.
 - 2. Floor flatness and levelness tolerances:
 - a. F_F defines maximum floor curvature allowed over 24 inches. Computed on the basis of successive 12-inch elevation differentials, F_F is commonly referred to as the "flatness F-Number."
 $F_F = \frac{4.57}{\text{Maximum difference in elevation, in decimal inches, between successive 12-inch elevation differences.}}$
 - b. F_L defines relative conformity of floor surface to horizontal plane as measured over 10-foot distance. F_L is commonly referred to as "levelness F-number."
 $F_L = \frac{12.5}{\text{Maximum difference in elevation, in inches, between two points separated by 10 feet.}}$
 - 3. Achieve specified overall slab tolerance. Minimum local tolerance (1/2 bay, unless otherwise designated by Project Manager): 2/3 of specified tolerance.
 - 4. Tolerance for floated finish: F_F20/F_L17 , unless otherwise shown on Drawings.
 - 5. Tolerance for troweled finish: F_F25/F_L20 for slabs on grade, and F_F25/F_L17 for elevated slabs, unless otherwise shown on Drawings.
- 3.13 CURING
- A. Conform to requirements of Section 03390 - Concrete Curing.

END OF SECTION

Section 03390
CONCRETE CURING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Curing of structural concrete.

1.02 UNIT PRICES

- A. No separate payment will be made for concrete curing under this Section. Include payment in unit price for structural concrete.

1.03 REFERENCES

- A. ACI 308 - Standard Practice for Curing Concrete.
- B. ASTM C 171 - Standard Specifications for Sheet Materials for Curing Concrete.
- C. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- D. ASTM D 44587 - Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light-and Water-Exposure Apparatus.

1.04 DEFINITIONS

- A. Mass Concrete: Concrete sections 4 feet or more in least dimension.

1.05 SUBMITTALS

- A. Conform to Section 01330 - Submittal Procedures.
- B. Product Data: Submit description of proposed curing method for concrete. When use of membrane-forming compound is proposed, submit manufacturer's technical information including material specifications, installation instructions and recommendations, and evidence that compound is satisfactory for intended application. State locations where curing compound will be used.
- C. When membrane-forming compounds are to be used, submit certification by the manufacturer of compliance with specified requirements and compatibility with toppings, coatings, finishes, and adhesives to be applied.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Membrane-forming Curing Compound: Conform to ASTM C 309, Type 1D, and following requirements.
 - 1. Minimum solids content: 30 percent.
 - 2. Compound shall not permanently discolor concrete. When used for liquid-containing structures, curing compound shall be white-pigmented.

3. When used in areas that are to be coated, or that will receive topping or floor covering, material shall not reduce bond of coating, topping, or floor covering to concrete. Curing compound manufacturer's technical information shall state conditions under which compound will not prevent bond.
4. Conform to local, state and federal solvent emission requirements.
- B. Clear Curing and Sealing Compound (VOC Compliant): Conform to ASTM C 309, Type 1, Class B, and the following requirements: 30 percent solids content minimum; non-yellowing under ultraviolet light after 500-hour test in accordance with ASTM D 4587. Sodium silicate compounds are not permitted. Conform to local, state and federal solvent emission requirements.
- C. Sheet Material for Curing Concrete: ASTM C 171; waterproof paper, polyethylene film or white burlap-polyethylene sheeting.
- D. Curing Mats (for use in Curing Method 2): Heavy shag rugs or carpets, or cotton mats quilted at 4 inches on center; 12 ounce per square yard minimum weight when dry.
- E. Water for curing: Clean and potable.

PART 3 EXECUTION

3.01 CURING PROCEDURES

- A. Comply with ACI 308 and the requirements specified herein. Protect freshly-deposited concrete from premature drying and excessively hot or cold temperatures. Maintain minimal moisture loss and relatively constant temperature during time necessary for hydration of cement and proper hardening of concrete.
- B. Unformed Surfaces: For concrete surfaces not in contact with forms, use one of following procedures immediately after completion of placement and finishing.
 1. Ponding or continuous sprinkling.
 2. Absorptive mat or fabric kept continuously wet.
 3. Sand or other covering kept continuously wet.
 4. Continuous steam bath (not exceeding 150 degrees F at surface of concrete).
 5. Vapor mist bath.
 6. Membrane-forming curing compound applied according to manufacturer's recommendations. After the curing compound has dried, wet slab surfaces and cover with waterproof paper, polyethylene film, or white burlap-polyethylene sheeting after the application of the curing compound. Tape sheet seams together and provide sufficient weights to keep the sheeting in place. Wet the slab surface again if the sheeting becomes dislodged, and replace the sheeting.
 7. Other moisture-retaining coverings as approved by Engineer.
- C. Restrictions on Use of Curing Compounds: Unless curing compound manufacturer certifies that curing compound will not prevent bond to cured surface, do not use curing compound on surfaces that will be rubbed or receive additional concrete,

mortar, topping, terrazzo or other cementitious finishing materials, on slabs under resilient floors or built-up roofing, or on surfaces to be waterproofed, sealed, hardened or painted.

- D. Curing and Sealing Compounds: At locations indicated, cure exposed interior slabs and troweled slabs receiving mastic-applied adhesives with specified clear curing and sealing compound in accordance with manufacturer's recommendations. Do not store materials directly on curing membranes. Use plywood to protect curing membrane from damage. Immediately repair membranes damaged by foot traffic or other operations.
- E. Duration of Curing: Continue curing until cumulative number of days or fractions of days during which ambient temperature is above 50 degrees F has totaled 7. Continue curing of water-retaining structures for a total of 14 days. When high-early-strength concrete has been used, continue curing for total of 3 days. Prevent rapid drying at end of curing period.
- F. Formed Surfaces: During the curing period keep wet steel forms heated by sun and wood forms in contact with concrete. When forms are to be removed during curing period, employ curing materials or methods immediately. Continue such curing for remainder of curing period.
- G. Temperature:
 - 1. Cold Weather. When mean daily temperature of atmosphere is less than 40 degrees F, maintain temperature of concrete between 50 and 70 degrees F for required curing period. When necessary, make arrangements for heating, covering, insulating or housing concrete work in advance of placement to maintain required temperature and moisture conditions. Prevent damage or injury due to concentration of heat. When combustion heaters are necessary in enclosed or protected area where concrete slabs are being placed, vent heaters.
 - 2. Hot Weather. In advance of placement make arrangements for shading, fog spraying, sprinkling, ponding or installation of windbreaks or wet covering of light color. Take such protective measures as quickly as concrete hardening and finishing operations will allow.
 - 3. Temperature Changes. Control so rate of change in temperature of concrete is as uniform as possible. Do not permit temperature change to exceed 5 degrees F in any one hour or 50 degrees F in any 24-hour period.
- H. Protection from Mechanical Injury. During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration. Protect finished concrete surfaces from damage caused by construction equipment, materials or methods, and by rain or running water. Do not load self-supporting structures in a way that over stresses concrete.

3.02 CURING MASS CONCRETE

- A. Observe the following additional restrictions when curing mass concrete.
 - 1. Minimum curing period: 2 weeks.

2. When ambient air temperature falls below 32 degrees F, protect surface of concrete against freezing.
3. Do not use steam or other curing methods that will add heat to concrete.
4. Keep forms and exposed concrete continuously wet for at least the first 48 hours after placing, and whenever surrounding air temperature is above 90 degrees F during final curing period.
5. During 2-week curing period, provide necessary controls to prevent ambient air temperature immediately adjacent to concrete from falling more than 30 degrees F in 24 hours.

END OF SECTION

Section 04061

MORTAR

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Mortar and grout for masonry and concrete structures.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for mortar under this Section. Include payment in Lump Sum for building or structure with price breakdown included in Schedule of Values.
 - 2. Refer to Section 01270 - Measurement and Payment and Section 01292- Schedule of Values.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.3 REFERENCES

- A. ASTM C 143 - Standard Testing Method for Slump of Hydraulic Cement Concrete
- B. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.
- C. ASTM C 150 - Standard Specification for Portland Cement.
- D. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- E. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
- F. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout.
- G. ASTM C 476 - Standard Specification for Grout for Masonry.
- H. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

- I. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Include design mix, indicate Property Method used, required environmental conditions, and admixture limitations.
- C. Samples: Submit two ribbons of each mortar color, illustrating color and color range.
- D. Submit test reports under provisions of Section 01450 - Contractor's Quality Control.
- E. Submit test reports on mortar indicating conformance to ASTM C 270.
- F. Submit test reports on grout indicating conformance to ASTM C 476.
- G. Submit manufacturer's certificate under provisions of Section 01450 - Contractor's Quality Control, that products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site and store and protect products under provisions of Section 01610 - Basic Product Requirements.
- B. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

1.7 MIX TESTS

- A. Test mortar and grout in accordance with Section 01454 - Testing Laboratory Services.
- B. Testing of Mortar Mix: Test in accordance with ASTM C 780. Test mortar mix for compressive strength, consistency, mortar aggregate ratio, water content, air content, and splitting tensile strength.

- C. Testing of Grout Mix: Test in accordance with ASTM C 109. Test grout mix for compressive strength and slump.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Portland Cement: ASTM C 150, Type I, white color.
- B. Masonry Cement: Not permitted.
- C. Mortar Aggregate: ASTM C 144, standard masonry type. Grading and color suitable for type of masonry, one source for entire project. (Not less than 5 percent shall pass No. 100 sieve).
- D. Hydrated Lime: ASTM C 207, Type S.
- E. Grout Aggregate: ASTM C 404.
- F. Water: Clean and potable.

2.2 MORTAR COLOR

- A. Mortar Color: Mineral oxide pigment; color; to be selected by Engineer from manufacturer's samples.

2.3 ADMIXTURES

- A. Antifreeze: Antifreeze admixtures will not be permitted.
- B. Accelerator: Accelerator may be used only with approval of Engineer.

2.4 MORTAR

- A. Mortar for Load Bearing Walls and Partitions: ASTM C 270, Type S utilizing Property Method to achieve 1800 psi strength.
- B. Mortar for Non-load Bearing Walls and Partitions: ASTM C 270, Type S utilizing the Property Method to achieve 1800 psi strength.
- C. Mortar for Use Below Grade or in Contact with Earth: ASTM C 270, Type M utilizing the Property Method to achieve 2500 psi strength.
- D. Pointing Mortar: ASTM C 270, Type N, using the Property Method to achieve 750 psi strength.

2.5 MORTAR MIXING

- A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C 270 to achieve strengths noted in Paragraph 2.04.
- B. Add mortar color and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.
- C. Do not use anti-freeze compounds to lower freezing point of mortar.
- D. If water is lost by evaporation, retemper only within 2 hours of mixing.
- E. Use mortar within 2 hours after mixing at temperatures of 80 degrees F, or 2 1/2 hours at temperatures under 50 degrees F.

2.6 GROUT

- A. Bond Beams, Lintels, and Other Areas to be Grouted Solid: 3000 psi strength at 28 days; 7 to 8 inches slump per ASTM C 143; mixed in accordance with ASTM C 476, Fine Grout.

2.7 GROUT MIXING

- A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C 476, Fine Grout.
- B. Add admixtures in accordance with manufacturer's instructions. Provide uniformity of mix.
- C. Do not use anti-freeze compounds to lower freezing point of grout.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Request inspection of spaces to be grouted.

3.2 PREPARATION

- A. Apply bonding agent to existing concrete surfaces.
- B. Plug clean out holes with masonry units to prevent leakage of grout materials. Brace masonry for wet grout pressure.

3.3 INSTALLATION

- A. Install mortar and grout in accordance with manufacturer's instructions.
- B. Work grout into masonry cores and cavities to eliminate voids.
- C. Do not displace reinforcement while placing grout.
- D. Remove grout spaces of excess mortar.

END OF SECTION

Section 04210

BRICK MASONRY FOR UTILITY CONSTRUCTION

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Brick masonry work in utility construction for temporary installation of below ground structures.
- B. Brick masonry in repair and rehabilitation of utility lines and associated structures.

1.2 UNIT PRICES

- A. No payment will be made for brick masonry under this Section unless specifically noted in bid documents. Include payment in unit price for applicable utility structure section.

1.3 REFERENCES

- A. ASTM C 32 – Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
- B. ASTM C 55 - Standard Specification for Concrete Building Brick.
- C. ASTM C 62 – Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).
- D. ASTM C 67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
- E. ASTM C 91 – Standard Specification for Masonry Cement.
- F. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens).
- G. ASTM C 140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
- H. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

1.4 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification from the manufacturer that brick units meet applicable requirements of reference standards.
- C. As an alternate to providing certification, submit test results that show brick units meet applicable requirements of reference standards, when tested by an approved independent testing laboratory. Test result submittals shall be at no cost to the Authority.

1.5 HANDLING AND STORAGE

- A. Handle and store brick to prevent damage.
- B. Store brick and mortar mix off the ground and in a dry place. Cover mortar mix to protect from weather.

PART 2 P R O D U C T S

2.1 CLAY AND SHALE BRICK MASONRY UNITS

- A. Manholes and Structures: Use brick units made from clay or shale conforming to requirements of ASTM C 32, Grade MM, either cored or solid. Units shall have the following physical properties:
 - 1. Compressive Strength: 2,200 psi minimum for individual brick; 2,500 psi average for five bricks.
 - 2. Size: 2-1/4" by 7-5/8" by 3-5/8".
 - 3. Test Procedure: ASTM C 67.
- B. Sewer Brick: Use brick units made from clay or shale conforming to requirements of ASTM C 32, Grade SM, either cored or solid. Units shall have the following physical properties:
 - 1. Compressive Strength: 3,750 psi minimum for individual brick; 5,000 psi average for 5 bricks.
 - 2. Size: 2-1/4" by 7-5/8" by 3-5/8".
 - 3. Test Procedure: ASTM C 67.

2.2 CONCRETE BRICK MASONRY UNITS

- A. Manholes and Structures: Conform to requirements of ASTM C 55, grade S-1.
- B. Dimensions: 2-1/4" by 7-5/8" by 3-5/8".

2.3 MORTAR

- A. Provided mortar conforming to the requirements of Section 4061 - Mortar.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Ensure that foundations and other surfaces to support brickwork are at proper grades and elevations. Correct improperly prepared surfaces. Work surfaces and masonry shall be free of dirt, grease, oil, or other harmful materials before starting brick masonry work.

3.2 WEATHER REQUIREMENTS

- A. Lay no masonry when temperature of outside air is below 50 degrees F, unless satisfactory means are provided to heat materials and protect work from cold and frost.
- B. Maintain mortar at 50 degrees F or above and ensure that mortar will harden without freezing.

3.3 BRICK PLACEMENT

- A. Use sewer brick where exposed to flow. Where not exposed to flow, use manhole brick.
- B. Lay sewer brick with the 2-1/4-inch by 7-5/8-inch side exposed to flow.
- C. Lay manhole bricks so that in every fifth course the long axis of bricks are perpendicular to the long axis of the four preceding courses.
- D. Lay curved courses, and courses in different planes, using bonded and keyed construction.
- E. Lay brick plumb and true with courses level and uniformly spaced. Adjust the bond of face brick so that no course will terminate with a piece less than one-half length of brick.
- F. Dampen brick prior to placement.
- G. Where fresh masonry joins partially set or totally set masonry, clean surfaces of set

masonry. Remove loose mortar and brick. Wet brick to obtain the best possible bond.

- H. Immediately remove mortar droppings and splashing as work progresses to facilitate final cleaning.

3.4 JOINTS

- A. Completely fill joints in brick and other materials with mortar as each course is laid.
- B. Make joints in exposed brickwork a uniform 3/8-inch wide, unless otherwise shown on Drawings.
- C. When mortar is "thumbprint" hard, tool exposed joints with a round or other suitable jointer that is slightly larger than width of the mortar joint. In tooling, make sure that cracks and crevices are closed.
- D. Point holes in exposed masonry. Cut out defective joints and repoint.

3.5 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. A minimum of one set of mortar samples shall be molded for each day's placement as directed by Engineer. Mold three 2-inch cube specimens. One cube will be tested for compressive strength at 7 days and 2 cubes will be tested for compressive strength at 28 days in accordance with ASTM C 109.
- C. Each load of bricks delivered to the jobsite shall be tested.
 - 1. Test clay bricks in accordance with ASTM C 67.
 - 2. Test concrete bricks in accordance with ASTM C 140.

END OF SECTION

Section 05501

METAL FABRICATIONS

PART 1 GENERAL

SECTION INCLUDES

- A. Bolts, anchors, nuts, sleeves, concrete anchors, scheduled items, and other miscellaneous metal items not specifically included under other sections of these specifications.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices
 - 1. No separate payment will be made for metal fabrications under this section. Include payment as part of the Work in appropriate sections.
 - 2. Refer to Section 01270 - Measurement and Payment.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 REFERENCES

- A. ASTM A 36 - Structural Steel.
- B. ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- C. ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- D. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A 276 - Stainless and Heat-Resisting Steel Bars and Shapes.
- F. ASTM A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- G. ASTM A 500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
- H. ASTM A 501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

- I. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - J. ASTM B308 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
 - K. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - L. ASTM B429 Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
 - M. ASTM F467 Standard Specification for Nonferrous Nuts for General Use
 - N. ASTM F468 - Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
 - O. ASTM F 593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - P. ASTM F 594 - Stainless Steel Nuts.
 - Q. AWS A 2.0 - Standard Welding Symbols.
 - R. AWS D 1.1 - Structural Welding Code.
 - S. SSPC - Steel Structures Painting Council.
- 1.4 SUBMITTALS
- A. Submit following Section 01330 - Submittal Procedures.
 - B. Shop Drawings: Indicate profiles, sizes, thickness, grade class, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - C. Indicate welded connections using standard AWS A 2.0 welding symbols. Indicate net weld lengths.
 - D. Submit manufacturer's technical literature and current test reports showing certified capacities for concrete anchors used as anchorage in cracked or un-cracked concrete conditions and at the specified temperature range. Provide reports for mechanical anchorage per ICC-ES AC193 and for adhesive anchorage per ICC-ES AC308.
 - E. When foreign manufactured material is proposed for use, test material for conformance to ASTM Standards by a certified independent testing laboratory

located in the United States. Certification from any other source outside the United States is unacceptable. Furnish copies of test reports to Engineer for review. Do not begin fabrication until material has been approved. No additional payment will be made for this testing.

1.5 QUALIFICATIONS

- A. Prepare shop drawings under direct supervision of a professional Structural Engineer experienced in design of this work and licensed in the State of Texas.
- B. Welders' Certificates: Submit following Section 01330 - Submittal Procedures, certifying welders employed on the Work, verifying AWS D1.1, Structural Welding Code, using procedures, materials and equipment of type required for this work. Welder must have been qualified or re-certified within the previous 12 months of date welding is being performed.

1.6 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on Drawings.

1.7 DELIVERY AND STORAGE

- A. Materials stored at project site: Store above ground on platforms, skids, or other supports. Keep free of dirt, mud, grease, or oil. Protect from corrosion.

PART 2 P R O D U C T S

2.1 MATERIALS

- A. Steel Shapes and Plate: ASTM A 36.
- B. Stainless Steel Sections: ASTM A 276, Type 316 for non-welded items and Type 316L for welded items.
- C. Aluminum: ASTM B221 and ASTM B308, alloy 6061-T6 minimum yield 32,000 psi for shapes including beams, channels, angles, tees, and zees. ASTM B209 for sheets and plates. ASTM B221 and ASTM B429, alloy 6063-T5 or T6, minimum yield 15,000 psi for bars, rods, wires, pipes and tubes.
- D. Steel Tubing: ASTM A 500 or ASTM A 501, Grade B.
- E. Pipe: ASTM A 53, Grade B Schedule 40.
- F. Bolts, Nuts, and Washers: ASTM A 307 galvanized to ASTM A 153 for galvanized components. Provide anchor bolts for all equipment and machinery

when anchor bolts are not furnished by manufacturer. Conform anchor size, length, projection, etc., to requirements of equipment and machinery manufacturer. Provide templates to accurately position anchor bolts in forms.

- G. Stainless Steel Bolts and Nuts: Bolts in accordance with ASTM F 593, Type 316; nuts in accordance with ASTM F 594, Type 316; UNC coarse threads.
- H. Aluminum Bolts and Nuts: Bolts in accordance with ASTM F 468, alloy 2024 T4; nuts in accordance with ASTM F 467, alloy 2024 T4; UNC coarse threads.
- I. Concrete Anchors: Concrete anchors are inserted into holes drilled in hardened concrete. Use one of the following types:
 - 1. Adhesive Anchors: For concrete anchors which are submerged, in splash zones, in enclosed spaces over liquids, or anchoring vibrating equipment, use epoxy adhesive anchors. Adhesive anchors may be used at all locations where concrete anchors are required. Epoxy systems shall be Simpson Strong Tie SET-XP, or SET 3G, HILTI HIT RE 500 V3, or equal when approved by the Engineer. Threaded rods shall be ASTM F 593, Type 316 studs. Where adhesive anchors, or connected metal, are exposed to direct sunlight, the anchors shall be certified to maintain at least 80 percent of their rated strength at long term temperature (tested at 110 F) when tested at short term elevated concrete temperature not less than 160 F.
 - 2. Expansion Anchors: Where concrete anchors are indicated and adhesive anchors are not required, and the anchorage is installed in un-cracked concrete conditions, wedge type anchors made with ASTM A 276, Type 316 Stainless Steel shall be used. Anchors shall be KWIK Bolt 3 By Hilti, Inc., or equal.
- J. Welding Materials: AWS D 1.1 or D1.2; type required for materials being welded.
- K. Shop and Touch-Up Primer: Same manufacturer as protective coating; compatible with protective coating; applied in accordance with manufacturer's recommendation.

2.2 FABRICATION

- A. Fit and shop-assemble in largest practical sections for delivery to site.
- B. Fabricate items with joints tightly fitted and secured. Weld all shop connections except where welding is not practical, or unless otherwise shown on Drawings. Where screw bolts cannot be avoided, conceal fasteners where possible or countersink heads, screw up tight and nick threads to prevent loosening. Weld joints continuously except as shown on Drawings.
- C. Form materials to shapes indicated with straight lines, true angles, and smooth

curves. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius. Provide drilled or punched holes with smooth edges. Punch or drill for field connections and for attachment of work by other trades.

- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Welding shall conform to requirements of AWS D1.1, Structural Welding Code – Steel, AWS D1.2 Structural Welding Code – Aluminum, or AWS D1.6 Structural Welding Code – Stainless Steel. Perform welding not governed by above in accordance with best modern practice for strength and durability. Welds to be continuous fillet type unless indicated otherwise. Grind smooth welds that will be exposed.
- G. Expansion joints in railings: Joints to be designed to allow expansion and contraction of railing and still meet design loads required. Top rail splices and expansion joints shall be located within 8 IN of post or other support. Provide expansion joints in any continuous run exceeding 20 FT in length. Space expansion joints at not more than 40 FT on center. Provide minimum 0.10 IN of expansion joint for each 20 FT length of top rail for each 25 Degree F differential between installation temperature and 140 Degree F. Maximum expansion joint width at time of installation shall not exceed 3/8 IN. Provide additional expansion joints as required to limit expansion joint width. Provide slip-joint with internal sleeve. Extend slip joint min 2 IN beyond joint at maximum design width. Weld or fasten internal sleeve securely to one side. Provide allen-head set screw, if fastened, located in bottom of rail.
- H. Railing Fabrication: Railings are to be welded type 3 finish or mechanically fastened component system. Mechanically fastened railing shall be an engineered system designed specifically for use as guardrail system. Fittings shall be internally connected, flush-fitting aluminum or stainless steel. Fasteners shall be 302 series stainless steel Allen head set screws. Fit exposed ends of guardrails and handrails with solid terminations. Return ends of handrail to wall, but do not attach to wall. Where guardrail terminates at a wall, provide a vertical post or end-loop 4 IN off the wall to center of vertical member. Preassemble items in shop to greatest extent possible

2.3 FINISHES

- A. Prepare surfaces to be primed in accordance with SSPC SP 2.

- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Galvanize, after completion of welded fabrication, in accordance with ASTM A 123, structural steel members. Provide minimum 2.0 ounces per square foot galvanized coating.
- D. Powder coated: Hot-dip galvanize after fabrication. Prepare galvanized surfaces in accordance with ASTM D6386. PVDF powder coating Minimum 70 PCT resin content. Meet requirements of AAMA 2605.

2.4 LADDERS

- A. Fully welded type: All welds to be full penetration welds, unless otherwise specified. All ladders of a particular material shall have consistent construction and material shapes and sizes unless noted otherwise on the Drawings. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and applicable Building Codes. Ladders shall be designed to support a minimum concentrated live load of 300 LBS at any point to produce the maximum stress in the member being designed. Apply additional 300 LB loads for each section of ladder exceeding 10 FT. Maximum allowable stresses per AA ADM 1 for aluminum ladders. Maximum allowable stresses per AISC Specification for steel and stainless steel ladders. Maximum lateral deflection: Side rail span/240 when lateral load of 100 LBS is applied at any location.
- B. Material: Aluminum, Galvanized steel, or Stainless steel Type 316, as shown on the Drawings for each specific ladder.
- C. Finish: As noted in below table.

MATERIAL	FINISH
Aluminum	Aluminum Mill
Steel	Galvanized
Stainless Steel	Satin

- D. Rails: Round pipe 1-1/2 IN nominal diameter Schedule 80, Rectangular tubing Cross-section: 3 by 2 IN maximum Thickness: 0.125 IN minimum. Minimum clear distance between rails to be 18 IN. Step-through ladder extensions: 24 IN, centerline to centerline. Provide cap at exposed top and bottom of side rails. Provide weep holes as necessary to prevent the accumulation of moisture within hollow members. Extend side rails of step-through ladders a minimum of 42 IN above the landing.
- E. Rungs: Minimum 1 IN DIA or 1 IN square solid bar, or 1 5/8 IN wide rung plank on 3/4 IN DIA solid rod. Non-slip finish: Coarse knurling or extruded serrations.

Rungs shall penetrate inside wall of side rails. Do not extend rungs beyond the outside face of the side rail. Provide fillet weld all around rung at inside face of side rail and plug weld at outside face of side rail. Uniform, 12 IN Rung spacing. Top rung shall be level with landing or platform. Where top of ladder terminates at grating cover, floor access door, roof hatch or similar condition; locate top rung as close as practicable to, but not more than 6 IN below, adjacent walking surface. Spacing of bottom rung from grade or platform may vary but shall not exceed 14 IN.

- F. Brackets: Angle or bent plate brackets welded to side rails: 3/8 IN by 2-1/2 IN by length required. Provide punched holes for 3/4 IN bolts or anchors. Minimum distance from centerline of rung to wall or any obstruction: 7 IN. Maximum spacing: 4 FT OC for aluminum, 6 FT OC for steel. For floor supported ladders, provide 3/8 by 2-1/2 by 4 IN rectangular bracket or 3/8 by 6 by 6 IN square plate welded to rails with punched holes for 3/4 IN bolts. Provide wall brackets on floor supported units if vertical run is over 4 FT.
- G. Landings: Construct landing, railing and all supports of same material as the ladder. Design live load for landing platform and supporting structure: 100 psf, uniform load. 300 LBS concentrated load on 4 IN square area. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component. Maximum deflection: 1/300 of span under a superimposed live load of 100 PSF.
- H. Deflector plate: For aluminum ladders: Minimum .0625 IN aluminum plate, ASTM B209. For stainless steel ladders: Minimum .0625 IN stainless steel plate, ASTM A666. For steel ladders: Minimum .0625 IN steel plate, ASTM A6. Profile as shown on Drawings. Fabricate to shapes and sizes required to meet OSHA Standards.
- I. Ladder safety extension post: Telescoping tubular, same material as ladder, section that automatically locks into place when fully extended. Non-ferrous corrosion-resistant spring and hardware. Factory assembled with all hardware necessary for mounting to ladder. Furnish as part of the ladder fall protection system for ladders extending more than four feet above the lower level or Bilco "LadderUp" safety post, or equal.
- J. Ladder fall protection system for ladders over four feet above the lower level: Extruded aluminum safety rail. Safety rail shall extend from within 3 FT of base of ladder to top of ladder side rails. Extruded aluminum trolley with brake. Full body harness with adjustable leg straps, backpad, and front dee ring. Miller Equipment "Saf-T-Climb.", or approved equal. Provide all components required for a complete OSHA compliant personal fall protection system.

2.5 GRATING

- A. Aluminum or Hot-Dipped Galvanized after fabrication: NAAMM MBG 531. Bearing bars Rectangular, 1-1/2 by 3/16 IN at 1-3/16 IN OC spacing, I bar, 1-1/2 IN deep with minimum 1/16 IN thick bar and minimum 1/4 IN flange width at 1-3/16 IN OC spacing, or as shown otherwise on Drawings. Cross bars welded, swaged or pressure locked to bearing bars, maximum 4 IN spacing, Top edges of bars grooved or serrated, stainless steel or hot dipped galvanized clips and bolts. Removable grating sections not wider than 3 FT and not more than 100LBS with trim bands, load bands, toe boards and openings where shown as banded. Provide full depth banding with alternate bearing bars welded to band unless noted otherwise. Banding at trenches and sumps to be 1/4 IN less than grating depth to allow for drainage. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned Aluminum, stainless steel, or hot dipped galvanized seat angles. Paint all aluminum surfaces in contact with concrete or dissimilar metals with a shop coat of bituminous paint.

2.6 RAILING

- A. Mill finish aluminum or Hot-Dipped Galvanized after fabrication: NAAMM AMP 521 . Custom fabricate pipe railings to dimensions and profiles indicated in a manner which complies with the indicated Building Code, Texas Accessibility Standards or 29 CFR 1910 OSHA Standard. Guardrail toprail Schedule 40 size 1 1/2 IN nominal diameter steel pipe or 2 IN nominal diameter aluminum pipe, midrail Schedule 40 size 1 1/2 IN nominal diameter, and vertical post Schedule 80 size 1 1/2 IN nominal diameter steel pipe or 2 IN nominal diameter aluminum pipe, spaced as required by loading but not to exceed 4 FT on center. Provide 4 IN toeboards on walkway side of all elevated walkways, platforms and stair landings, and where indicated on the Drawings or required by OSHA Standards. Handrail mounted to wall or to guardrail vertical posts: 1-1/4 IN nominal diameter Schedule 40 pipe. Avoid locating vertical posts at changes in direction of railing. Hold vertical post back from corner and provide radiused corners. Space handrail brackets as required by loading requirements but not more than 4 FT on center.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete or embedded in masonry with setting

templates, to appropriate sections.

- C. Coat stainless steel threads with an anti-seizing compound prior to installing nuts.

3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components indicated on shop drawings.
- D. Perform field welding in accordance with AWS D 1.1.
- E. Obtain Engineer approval prior to cutting or making adjustments in the field.
- F. After erection, prime welds, abrasions, and surfaces not shop primed except surfaces to be in contact with concrete.

3.4 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset from True Alignment: 1/4inch.

3.5 COATING REPAIRS

- A. Thoroughly clean field welds, abrasions, and damaged or defective areas of galvanized surfaces to remove all loose, cracked or bruised splatter coating. After surface is prepared, for galvanized surfaces apply two coats of galvanizing repair coating, as approved by Engineer. Repair other coated surfaces in accordance with manufacturer's recommendations, unless otherwise specified.

END OF SECTION

Section 06610

FIBERGLASS REINFORCED PLASTICS (FRP) FABRICATIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section includes shop fabricated fiberglass reinforced plastic (FRP) pultruded and molded gratings and treads, structures, handrails and ladders where noted on the drawings.
- B. Gratings: Furnish and install pultruded fiberglass reinforced plastic (FRP) high load capacity grating with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation as specified herein.
- C. Ladders: Furnish and install pultruded fiberglass reinforced plastic (FRP) ladder system, in compliance with OSHA 1910.27, with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation as specified herein.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices
 - 1. No separate payment will be made for FRP fabrications under this section. Include payment as part of the Work in appropriate sections.
 - 2. Refer to Section 01270 - Measurement and Payment.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.3 REFERENCES

- A. The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test
Methods:

ASTM D-638-Tensile Properties of Plastics

ASTM D-790-Flexural Properties of Unreinforced and Reinforced Plastics

ASTM D-2344-Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method

ASTM D-495-High Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

ASTM D-696-Coefficient of Linear Thermal Expansion for Plastics

ASTM E-84-Surface Burning Characteristics of Building Materials

THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)
Code of Federal Regulations (CFR), Title 29, Section 1910.27

1.4 CONTRACTOR SUBMITTALS

- A. Submit manufacturer's shop drawings of fabricated ladder, cages and accessories in accordance with the provisions of this Section.
- B. Submit manufacturer's shop drawings of all fabricated gratings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners and connection details.
- C. Submit manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
- D. Submit the manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.
- E. Submit sample pieces of each item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the work.

1.5 QUALITY ASSURANCE

- A. Items to be provided under this Section shall be furnished only by manufacturers

having a minimum of ten (10) years experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.

- B. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.
- C. Manufacturer shall be certified to the ISO 9001-2008 standard.
- D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

1.6 PRODUCT DELIVERY AND STORAGE

- A. Gratings and components shall be shop fabricated, piece match marked to assembly or erection drawings.
- B. Delivery of Materials: All manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- C. Storage of Products: Materials – before, during and after shipment - shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

1.7 DESIGN CRITERIA

- A. The design criteria of the FRP products, including connections, shall be in accordance with governing building codes and generally accepted standards in the FRP industry.
- B. Gratings: Design live loads of the FRP gratings for walkway applications shall be 100 psf uniformly distributed load (or as required by the governing building code) with a maximum deflection of 1/4" or L/240 at the center of a simple span.
- C. Structures: Structures shall be designed for 100 psf live load with a maximum deflection of L/180 for the structural member being considered.
- D. Stair Treads: Stair treads shall be designed for a uniform live load of 100 psf on the simple span of the tread OR a 300 pound line load at the center of the tread, whichever produces the greater stress.

PART 2 - PRODUCTS

2.1 GENERAL

- A. FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- B. Fiberglass reinforcement shall be continuous roving in sufficient quantities as needed by the application and/or physical properties required.
- C. Resin shall be Vinyl Ester with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.
- D. Finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. Glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- E. Grating products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test. Gratings shall not burn past the 25 mm reference mark and will be classified HB per ASTM D635.
- F. Mechanical grating clips shall be manufactured of Type 316SS (stainless steel).

2.2 LADDER FABRICATION

- A. Ladder side rails, rungs, ladder mounting brackets and cage straps are to be FRP structural shapes manufactured by the pultrusion process. Cage hoops and brackets shall be produced by the open molded hand lay-up method. Structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, bi-directional roving mat and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
- C. Resins shall be vinyl ester with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.
- D. Finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

- E. Pultruded ladder components shall be further protected from ultraviolet (UV) attack with integral UV inhibitors in the resin and a synthetic surfacing veil to help produce a resin rich surface.
- F. FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.
- G. The ladder side rail shall be 1-3/4" square tube with a wall thickness of 1/4" or greater. The rungs shall be 1-1/4" diameter pultruded structural shapes, continuously fluted to provide a non-slip surface. Rungs that are gritted as a secondary operation shall not be permitted. Ladder wall and floor mount shall be fabricated from pultruded angles, 3/8" minimum thickness.
- H. The ladder cage vertical bars shall be 1.5" wide by 5/8" pultruded I-beam shapes to offer protection to workers from exposed hardware. Cage hoops and cage brackets shall be manufactured by the open mold hand lay-up process. All cage hoops shall be 3" wide by 1/4" thick minimum.
- H. Type 316 stainless steel bolts shall be provided for attaching ladder cage vertical bars to hoops, ladder hoops to brackets, ladder cage brackets to the ladder, and wall brackets to the ladder.
- I. Ladder rungs shall be both mechanically attached to the ladder with stainless steel rivets and chemically bonded with epoxy.
- J. Ladder and cage components shall be integrally pigmented yellow. Wall and floor mount brackets shall be isophthalic polyester resin plus a flame retardant and manufactured in gray.
- K. Pultruded structural shapes used in the ladder system are to have the minimum longitudinal mechanical properties listed below:

Property	ASTM Method	Value	Units
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5×10^6 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8×10^6 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8×10^6 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)

Coefficient of Thermal Expansion	D-696	8.0×10^{-6} (1.4×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

- M. Fasteners used in the ladder system are to be 316 SS. Rivets will be 18-8 stainless steel.
- N. Ladders and cages shall be designed and laid out in strict accordance with OSHA 1910.27.
- O. Rungs shall penetrate the wall of the tube side rails and shall be connected to the rails with both epoxy and rivets to provide both a chemical and mechanical lock, respectively.
- P. Ladders shall be fully shop assembled. Ladder cages shall be test assembled and drilled to ensure a proper fit in the field. Ladder cage brackets shall remain attached to the ladder for shipping, but ladder cage components shall be disassembled, packaged, and shipped separately to ensure the lowest freight costs and to prevent damage in transit. Cage components shall be bundled with each respective ladder.
- Q. The hoop brackets shall be shop attached to the ladder with bolts. The hoops shall be field attached to the hoop brackets.
- R. Cut or machined edges, holes and notches shall be sealed to provide maximum corrosion resistance. Field fabricated cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

2.3 GRATING FABRICATION

A. Manufacture:

1. Pultruded: High strength and high stiffness pultruded elements having a maximum of 65% of glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Bearing bars shall be interlocked and epoxied in place with a two-piece cross rod system to provide a mechanical and chemical lock.
2. Molded: One piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square mesh pattern providing bidirectional strength. Gratings shall be reinforced with rovings of equal number of layers in each direction. The top layer of reinforcement shall be no more than 1/8" below the top surface of the grating so as to provide maximum stiffness and prevent resin chipping of

unreinforced surfaces. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements of the CONTRACT.

After molding, no dry glass fibers shall be visible on any surface of bearing bars or cross bars. All bars shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas. Grating shall be manufactured with a secondarily applied grit on the top of each bar providing excellent slip resistance.

B. Minimum Grating Design Criteria (Pedestrian Loads):

1. Uniform Live Load = 100 lb/ft²
2. Concentrated Load = 250 lb
3. Dead Load = 3.75 lb/ft²
4. Maximum Deflection Span = L/120, or 3/8" (whichever is less)

C. Color: Green, Yellow or Dark Gray. Authority shall select color.

D. Depth: 1" or 1-1/2" with a tolerance of $\pm 1/16$ ".

E. Non-slip surfacing: Grating shall be provided with an aluminum oxide grit bonded and baked to the top surface of the finished grating product and sealed with a compatible resin to insure retention of grit particles.

F. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the engineer for approval.

G. Measurements: Grating supplied shall meet the dimensional requirements and tolerances as shown or specified. Contractor shall provide and verify measurements in the field for work fabricated to fit field conditions as required by grating manufacturer to complete the work.

H. Layout: Each grating section shall be readily removable, except where indicated on the drawings. Gratings shall be fabricated free from warps, twists, or other defects which affect appearance and serviceability

I. Sealing: Shop fabricated grating cuts shall be resin sealed to provide maximum corrosion resistance. Field fabricated grating cuts shall be coated similarly by Contractor in accordance with manufacturer's instructions.

J. Hardware: Type 316 stainless steel hold-down clips shall be obtained by the Contractor and spaced in accordance with manufacturer's recommendation.

2.4 HANDRAIL FABRICATION

- A. All handrail systems shall be compliant to OSHA 1910.23
- B. All posts, rails and toeplates and FRP structural shapes shall be manufactured by the pultrusion process.
- C. Top rails, midrails and posts shall be 2 x 3/16" wall (50.8 mm x 4.8 mm) square tube. The base of the posts are to be reinforced to a height of 10" (254 mm) using a high strength epoxy compound or solid bar. Kickplate is to be 1/2" deep x 4" high (12.7 mm x 201.6 mm) with two reinforcing ribs.
- D. The top rail-to-post connection is to be fabricated such that the top rail is unbroken and continuous over the post with the use of internal splice. The mid rail is to be installed to a solid plug that is continuous through the post. The rails are to be joined to the post through a combination of bonding and riveting. No sharp, protruding edges are to remain after assembly of the handrail. Spacing of the posts shall not exceed 6'-0" (1.83 m).
- E. All rails, posts, and kick plates are to be integrally pigmented yellow.
- F. Handrails to be located outdoors in direct UV shall be shop coated with a two-part polyurethane coating, 2 mils thick minimum, for improved durability and UV resistance.
- G. All fasteners used in the railing system are to be 316 SS. Rivets will be 18-8 SS.

2.5 STRUCTURAL SHAPES

- A. All structural shapes are to be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight for maximum sunlight and chemical resistance. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- B. Pultruded structural shapes are to have the minimum longitudinal mechanical properties listed below:

Property	ASTM Test Method	Value	Units
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5×10^6 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8×10^6 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8×10^6 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	8.0×10^{-6} (1.4×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

2.6 MANUFACTURERS

A. Pultruded FRP Ladder System with Cage

1. Dynarail® as manufactured by Fibergrate Composite Structures Inc., 5151 Belt Line Road, Suite 1212, Dallas, Texas 75254-7028.
2. AmeriShapes as manufactured by American Grating, LLC, 1191 Center Point Drive, Henderson, NV 89074
3. Approved equal.

B. Pultruded FRP Grating System

1. Safe-T-Span as manufactured by Fibergrate Composite Structures Inc., 5151 Belt Line Road, Suite 1212, Dallas, Texas 75254-7028.
2. Approved equal.

C. Molded FRP Grating System

1. Gridwalk as manufactured by American Grating, LLC, 1191 Center Point Drive, Henderson, NV 89074
2. Approved equal.

D. Pultruded FRP Handrail System

1. AmeriRail as manufactured by American Grating, LLC, 1191 Center Point Drive, Henderson, NV 89074
2. Approved equal.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION INSPECTION

- A. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided.
- B. The grating shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits. The surface shall have a smooth finish.

3.2 INSTALLATION

- A. Contractor shall install ladders and gratings in accordance with manufacturer's assembly drawings and written instructions.
- B. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drill surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.
- C. Grating panels, when in place, shall be firmly fastened to their supports using a minimum of two hold down clips at a maximum spacing of 4'-0" on center per support with a minimum of four hold down clips per grating panel. Gratings installed in trenches may installed without hold down clips if the grating is adequately restrained to prevent horizontal sliding, vertical lifting, or tipping.
- D. Contractor shall be required to assemble and install ladder in strict accordance with manufacturer's assembly drawing and installation brochure.

3.3 PERFORMANCE REQUIREMENTS

- A. The completed ladder and cage system installation shall meet the following load requirements set forth in OSHA 1910.27. The ladder shall also be capable of supporting a concentrated vertical load of 1,200 pounds applied at the mid-span of the rung. Manufacturer shall be required to provide supporting test data for rung capacity.

END OF SECTION

Section 09901

PROTECTIVE COATINGS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

- A. Preparing surfaces, providing adequate conditions for proper workmanship, and furnishing and applying the protective coating materials required for metallic, concrete, masonry and plastic surfaces.
- B. Color code painting of piping and piping identification signs and markers.

1.2 UNIT PRICES

- A. No separate payment will be made for protective coatings unless specifically listed in Exhibit 1 – Contractor’s Bid. Include payment for protective coatings in unit prices for items to which coatings are applied.
- B. Measurement for protective coatings, when included as a separate pay item, is on a square- foot basis for completed protective coating systems.
- C. Refer to Section 01270 – Measurement and Payment for unit price procedures.

1.3 REFERENCES

- A. ANSI A13.1 – Color Schedule
- B. ANSI/AWWA C213 – Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
- C. Federal Standard 595A – Federal Standard Colors.
- D. Military Specification DOD-P-23236 – Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast, Class 2.
- E. NSF Standard 61 – Drinking Water System Components – Health Effects.
- F. SSPC-PA 1 – Paint Application Specification No. 1 - Shop, Field and Maintenance Painting.
- G. SSPC-PA 2 – Paint Application Specification No. 2 – Measurement of Dry Paint Thickness with Magnetic Gages.

- H. SSPC-Paint 16 – Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint.
- I. SSPC-SP 1 – Solvent Cleaning.
- J. SSPC-SP 2 – Hand Tool Cleaning.
- K. SSPC-SP 3 – Power Tool Cleaning.
- L. SSPC-SP 5/NACE 1 – White Metal Blast Cleaning.
- M. SSPC-SP 6/ NACE 3 – Commercial Blast Cleaning.
- N. SSPC-SP 7/NACE 4 - Brush-Off Blast Cleaning.
- O. SSPC-SP 10/NACE 2 – Near White Metal Blast Cleaning.
- P. SSPC-SP 11 – Power Tool Cleaning to Bare Metal.
- Q. SSPC-VIS 1-89 – Visual Standard for Abrasive Blast Cleaned Steel.
- R. SSPC-VIS 3 – Visual Standard for Power-and Hand-Tool Cleaned Steel.
- S. SSPC-QP 1 – Standard Procedure for Evaluating Qualifications of Painting Contractors
- T. SSPC-QP 2 - Standard Procedure for Evaluating Qualifications of Painting Contractors to Remove Hazardous Paint.
- U. SSPC-SP12/NACE 5 – Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Recoating.

1.4 DEFINITIONS

- A. Paint, coatings, or finishes as used in this Section include surface treatments, emulsions, enamels, paints, epoxies, polyurethanes, acrylics, zincs, and other protective coatings with the exceptions of galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.
- B. DFT means minimum dry film thickness.
- C. VOC means Volatile Organic Components

1.5 PERFORMANCE REQUIREMENTS

- A. See the Drawings and other Specifications to determine how coatings under this

Section will be applied. Paint or coat new and modified surfaces in conformance with this Section.

- B. Coating system schedules summarize surfaces to be coated, required surface preparation, and coating systems to be applied. Coating notes on Drawings are used to show exceptions to schedules, to show or extend limits of coating systems, or to clarify or show details for application of coating systems.
- C. Do not apply protective coatings to the following surfaces unless specifically named or shown to be coated;
 - 1. Concrete.
 - 2. Stainless steel, bronze, or brass.
 - 3. Machined surfaces.
 - 4. Grease fittings.
 - 5. Glass.
 - 6. Equipment nameplates.
 - 7. Platform gratings, stair treads, door thresholds, and other walk surfaces.
 - 8. Galvanized steel electrical conduit and associated galvanized and factory-coated junction boxes and electrical panels.
 - 9. Galvanized surfaces inside buildings and not exposed to view.
 - 10. Manhole and valve covers and rings, storm water inlet gratings, covers, and frames.
- D. Provide decorative and protective coatings for interior architectural surfaces such as wood, gypsum board, and masonry in accordance with Section 09900 – Painting.

1.6 SUBMITTALS

- A. Make submittals in accordance with Section 01330 – Submittal Procedures.
- B. Submit the following information at least 10 days prior to protective coating work.
 - 1. Coating Materials List: Eight copies of a coating materials list naming the manufacturer and the coating number, keyed to the coating systems described in this Section. Submit the list prior to or at the time of sample submittal.

2. Paint Manufacturer's Information: For each coating system to be used, submit the following data:
 - a) Paint manufacturer's Product Data Sheet for each product proposed, including statements on the suitability of the material for the intended use.
 - b) Technical and performance information that demonstrates compliance with the system performance and material requirements.
 - c) Paint manufacturer's instructions and recommendations on surface preparation, application and curing.
 - d) Colors available for each product, where applicable.
 - e) Compatibility of shop and field applied coatings, where applicable.
 - f) Material Safety Data Sheets for each product used.
 - g) VOC of each paint or coating proposed, stated in grams per liter.
3. Samples
 - a) Submit color samples of paint, finishes, and other coating materials on 8-1/2 inch by 11-inch sheet metal or heavy cardstock. Have each sheet completely coated over its entire surface with one protective coating material, type, and color.
 - b) Provide two sets of color samples to match each color selected by the Authority Engineer from the manufacturer's standard color sheets. If custom-mixed colors are indicated, prepare color samples using color formulations prepared to match the color samples furnished by the Authority Engineer.
 - c) Submit one 15-pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

1.7 QUALIFICATIONS

- A. Where protective coatings are to be applied by a Contractor, employ a Contractor who possesses a valid state license as required for performance of painting and coating work called for in this Specification.

- B. Submit 5 references, which show that the painting Contractor has previous successful experience with the indicated or comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the painting Contractor provided the protective coating. As an alternative, submit proof of certification in accordance with SSPC-QP 1.
- C. For any project which involves removal or repair of lead based paints, submit proof of certification in accordance with SSPC-QP 2.

1.8 ENVIRONMENTAL RESTRICTIONS

- A. Ventilate area where coating is being applied. Post and enforce NO SMOKING OR OPEN FLAME signs until coating has cured.
- B. Provide lighting level of 80-foot candles (860 1x) measured mid-height at substrate surface.
- C. Restrict worker access and construction traffic from area where coating is being applied or is cured.
- D. Comply with Authority and all applicable OSHA confined space entry regulations including but not limited to OSHA Permit-Required Confined Space Standard 1910.146.

1.9 WARRANTY INSPECTION AND MAINTENANCE

- A. Warranty Inspection:
 - 1. A warranty inspection may be conducted during the eleventh month following completion of coating and painting. The Contractor and a representative of the coating material manufacturer along with a NACE Certified Coating Inspector acting as the representative of the Authority Engineer, shall attend this inspection.
 - 2. The Authority Engineer may, by written notice to the Contractor, reschedule the warranty inspection to another date within the one-year correction period, or may cancel the warranty inspection altogether. Cancellation of the warranty inspection does not relieve the Contractor of his responsibilities under the Contract Documents.
 - 3. Repair defective work discovered during the warranty inspection in accordance with these Specifications.
- B. Extended Maintenance of Chemical Tank Lining Systems: Promptly repair defects in the chemical resistant sheet lining system for a period of 2 years after the lining has been placed into service. Such maintenance includes repair of the chemical tank

and any equipment or facilities damaged by the corrosive action of the chemicals.

PART 2 P R O D U C T S

2.1 COATINGS CRITERIA

- A. Suitability: Use suitable coating materials as recommended by the manufacturer. Recommendations must be accompanied by test methods used to determine suitability and results of these tests.
- B. Compatibility: In any coating system, use only compatible materials from a single manufacturer. Give particular attention to compatibility of primers, intermediate coats and finish coats. If necessary, apply a barrier coat or tie coat between existing prime coat and subsequent field coats to ensure compatibility.
- C. Containers: Supply coating materials in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all plainly legible at the time of use.
- D. Colors: Use colors and shades of colors of all coats of paint as indicated on the coating schedules or as selected by the Engineer. Make each coat a contrasting shade to the previous and following coats to facilitate inspection of surface coverage of each coat. The Engineer will select finish colors from the manufacturer's standard color samples.
- E. Substitute or Equal Products:
 - 1. To establish equality under Section 01630 – Product Substitution Procedures, furnish satisfactory documentation from the manufacturer of the proposed substitute product that the material meets the indicated requirements and is equivalent or better in the following properties:
 - a) Resistance to abrasion and physical damage.
 - b) Resistance to chemical attack.
 - c) Life expectancy.
 - d) Ability to recoat in the future.
 - e) Solids content by volume.
 - f) Dry film thickness per coat.
 - g) Compatibility with other coatings.

- h) Suitability for the intended service.
 - i) Temperature limitations in service and during application.
 - j) Type and quality of recommended undercoats and topcoats.
 - k) Ease of application.
 - l) Ease of repairing damaged areas.
 - m) Stability of colors.
 - n) VOC content expressed in grams per liter.
2. For substitutions, submit protective-coating materials which are standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, provide the Engineer with the names of not less than 10 successful applications of the proposed manufacturer's products, which comply with these requirements. Applications must be in similar service environments to the job being contracted.

2.2 INDUSTRIAL COATING SYSTEMS

- A. Material Sources: Each of the following manufacturers is capable of supplying many of the specified industrial coating materials. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials will be considered as indicated under paragraph 2.01.5. Provide industrial coating materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

- 1. Ameron International
- 2. Carboline Coatings Company
- 3. AKZO/ICI/Devco Coatings
- 4. Sigma Coatings USA, Inc.
- 5. Hempel Coatings USA, Inc.
- 6. Sherwin Williams
- 7. Tnemec Company

- B. System 1 – Aliphatic Polyurethane Finish Coat: Use a two-component aliphatic acrylic polyurethane coating. Provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering, and have a minimum solids content of 58 percent by volume. As primer, use a rust inhibitive 2- component epoxy coating with minimum solids content of 66 percent by volume.

1. Prime Coat:

- a) DFT = 4-6 mils (100-150 microns).
- b) Products: Ameron 385, Carboline 893, Tnemec 69, VyGuard V75, or equal.

2. Finish Coats (one or more):

- a) DFT = 2-4 mils (50-100 microns).
- b) Products: Ameron 450 GL, Carboline 134 HG, Tnemec 74, VyGuard V54, or equal.

3. Total System = 6-10 mils (150-250 microns).

4. Apply more than one finish coat as necessary to produce a finish with uniform color and texture.

- C. System 2 – Inorganic Zinc/Epoxy Polyurethane: For prime coat, use a 2-component water or solvent-based inorganic zinc silicate which contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. As intermediate coat, use a high-build, 2-component epoxy with a solids content of at least 70 percent by volume. For finish coats, use a 2-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58 percent by volume.

1. Prime Coat:

- a) DFT = 2.5-4.0 mils (65-100 microns).
- b) Products: Ameron Dimetecote 21-5 or 21-9, Carbozinc 11 or D7WB, VyGuard 13F6 or 13F7, or equal.

2. Intermediate Coat:

- a) DFT = 4-6 mils (100-150 microns).
 - b) Ameron 385, Carboline 893, VyGuard V75, or equal.
 - 3. Finish Coats (one or more):
 - a) DFT = 2.5 to 4.0 mils (65-100 microns).
 - b) Ameron 450 GL, Carboline 134 HG, VyGuard V54, or equal.
 - 4. Total System DFT = 9-14 mils (225-600 microns).
 - 5. Apply intermediate coat in excess of 4 mils (100 microns) DFT using the mist coat/full coat technique to completely cover the inorganic zinc primer and prevent bubbling of the epoxy or polyurethane finish coat.
 - 6. Apply more than one finish coat as necessary to produce a finish with uniform color and texture.
 - 7. If inorganic zinc primer is used as a pre-construction or shop-applied primer, and there are damaged or uncoated areas, spot blast the damaged area with abrasive to an SSPC-SP 10 Near White Metal Standard and then coat with the specified material.
- D. System 3 – Inorganic Zinc: Use a 2-component water-based inorganic zinc silicate which contains at least 85 percent of metallic zinc by weight in the dried film.
- 1. Prime Coat and Finish Coat (one).
 - a) DFT = 2.5 to 4.0 mils (65-100 microns).
 - b) Products: Ameron Dimetcote 21-5, Carbozinc D7WB, VyGuard 13F6 or 13F7, or equal.
 - 2. Total System DFT = 2.5 to 4.0 mils (65-100 microns).
- E. System 4 – Acrylic Latex: Use a single component, water-based acrylic latex with a fungicide additive having a minimum solids content of 35 percent by volume. Apply a prime coat as recommended by manufacturer. Select coating material, which is available in ANSI safety colors.
- 1. Prime Coat:
 - a) DFT = 2-3 mils (50-75 microns).
 - b) Products: Carboline D3358, Ameron 148, Hemucryl 1803.

2. Finish Coats (2 or more):
 - a) DFT = 6-8 mils (150-200 microns).
 - b) Products: Carboline D3359, Ameron 220, Hemucryl 4803, or equal.
 3. Total System DFT = 8-11 mils (200-275 microns).
- F. System 5 – Epoxy: Use a two-component, rust inhibitive, polyamide-cured epoxy coating material with a recoatable finish that is available in a wide selection of colors. Coating shall have a minimum solids content of 66 percent by volume and shall be resistant to service conditions of condensing moisture, splash and spillage of lubricating oils, and frequent wash down and cleaning.
1. Prime Coat:
 - a) DFT = 3-5 mils (75-125 microns).
 - b) Products: Ameron 385PA, Carboline 193, Tnemec 69, VyGuard V75, or equal.
 2. Prime Coat (where shop applied):
 - a) DFT = 3-5 mils (75-125 microns).
 - b) Products: Ameron 370, Carboline 193, Tnemec 161, VyGuard V75, or equal.
 3. Finish Coats (2 or more):
 - a) DFT = 5- 7 mils (125-175 microns).
 - b) Products: Ameron 385, Carboline 893, Tnemec 69, VyGuard V75, or equal.
 4. Total System DFT = 8-12 mils (200-300 microns).
- G. System 6 – Aliphatic Polyurethane, Fiberglass: Use a two-component aliphatic polyurethane coating material with superior color and gloss retention, resistance to splash from acid and alkaline chemicals, and resistance to chemical fumes and severe weathering. Use a primer, tie coat, or mist coat as recommended by the manufacturer.
1. Prime Coat (Tie Coat): Ameron 385, Carboline 893, Tnemec P66, VyGuard

- V75, or equal.
2. Finish Coats (2 or more):
 - a) DFT = 2-4 mils (50-75 microns).
 - b) Products: Ameron Amershield, Carbothane 134 HG, Tnemec 74, VyGuard V54, or equal.
- H. Section 7 – Alkyd Enamel: Use a high quality, gloss, or semi-gloss, medium long oil alkyd finish with a minimum solids content of 49 percent by volume. Apply primer as recommended by manufacturer.
1. Prime Coat:
 - a) DFT = 2-3 mils (50 to 75 microns).
 - b) Products: Ameron 5105, Carboline AD29, Tnemec P4-55, VyGuard 13R29, or equal.
 2. Finish Coats (2 or more):
 - a) DFT = 2-4 mils (50-75 microns).
 - b) Products: Ameron 5401HAS, Carboline GP62, Tnemec 2H, VyGuard V20, or equal.
 3. Total System DFT = 4-7 mils (100-175 microns).
- I. System 8 – Aluminum Metal Isolation: Use one coat of a high-build polyamide epoxy paint.
1. Products: Tnemec P66, Ameron 385, Carboline 893, Tnemec P66, VyGuard V75, or equal.]
 2. Total System DFT = 6-8 mils (150-200 microns).
- J. System 9 – Aluminum Silicone Resin: Use an aluminum silicone resin material suitable for a service temperature of up to 1000 degrees F (538 degrees C). Coating shall comply with Federal Specification DOD-P-28.
1. Prime Coat and Finish Coat (2 or more):
 - a) DFT = 2-4 mils (50-100 microns).
 - b) Products: Tnemec 39-1061, Ameron 878, Carboline 4631, VyGuard V437A1, or equal.

- c) Total System DFT = 2-4 mils (50-100 microns).
- K. System 10 – Zinc Rich Epoxy: Use a polyamide Epoxy resin material which contains at least 76 percent zinc in the dried film.
 - 1. Prime Coat and Finish Coat (2 or more):
 - a) DFT = 3-5 mils (75-125 microns).
 - b) Products: Ameron 68HS, Carboline 858, VyGuard 13F4, or equal.
 - c) Total System DFT = 3-5 mils (75-125 microns).

2.3 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

- A. Material Sources: The manufacturers listed in this paragraph are materials, which satisfy the material descriptions of this paragraph and have a documented successful record for long- term submerged or severe service conditions. Proposed substitute products will be considered as indicated under paragraphs 2.01.5.
- B. System 100 – Amine-Cured Epoxy: Use a high-build amine-cured epoxy with a solids content of at least 80 percent by volume. Coating shall be suitable for long-term immersion in potable water. For potable water service, select a coating material listed in the NSF 61 Standard.
 - 1. Prime Coat and Finish Coats (3 or more):
 - a) DFT = 16-19 mils (400 to 475 microns).
 - b) Products: Ameron Amercoat 395, Carboline 891, Tnemec 139, or equal.
 - 2. For coating of valves and non-submerged equipment, DFT = 12-14 mils (300-350 microns).
- C. System 101 – Polyamide Cured Epoxy: Use a high-build, polyamide epoxy resin with a solids content of at least 56 percent by volume. Coating shall be suitable for long-term immersion in potable water. For potable water service, select a coating material listed under NSF 61 Standard.
 - 1. Prime Coat and Finish Coats (3 or more):
 - a) DFT = 12-14 mils (300-350 microns).

- b) Products: Tnemec 20, VyGuard 78PR, or equal.
- D. System 102 – Coal Tar Epoxy: Use a high-build 2-component amine or polyamide-cured coal tar epoxy with a solids content of at least 68 percent by volume. Coating shall be suitable for long-term immersion in wastewater and for coating of buried surfaces. Coating shall conform to Mil Spec DOD-P-23236, or to SSPC Paint 16. Prime coats are for use as a shop primer only. Omit prime coat when both surface preparation and coating are performed in the field.
- 1. Prime Coat: DFT = 1.5-2.5 mils (38-65 microns).
 - a) Products: Ameron Amercoat 83HS, Tnemec P66, VyGuard V75, or equal.
 - 2. Finish Coats (2 or more):
 - a) DFT = 14-18 mils (350-450 microns).
 - b) Products: Ameron 78HB, Carbomastic 14, Tnemec 46H413, VyGuard 64, or equal.
 - c) Total System DFT = 15.5-20.5 mils (387-513 microns).
- E. System 103 – Fusion Bonded Epoxy: Use a 100 percent powder epoxy applied in accordance with ANSI/AWWA C213, except that surface preparation shall be as specified in the coating system schedule of this Section. Apply the coating using the fluidized bed process.
- 1. Liquid Epoxy: For field repairs, use a 100 percent solids liquid epoxy as recommended by the powder epoxy manufacturer to provide a DFT of 15-17 mils (375-425 microns).
 - 2. Powder Coating:
 - a) DFT = 15-17 mils (375-425 microns).
 - b) Products: Scotchkote 134 or 206N, Napgard 7-0008 or 7-2500, or equal.
 - c) Total System DFT = 15-17 mils (375-425 microns).
 - d) For coating of valves, DFT = 11-12 mils (275-300 microns).
- F. System 104 – Chemical Resistant Sheet Lining:
- 1. Materials: Use natural rubber, chlorobutyl rubber, ethylene propylene diene

monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining material. Submit shop drawings containing technical information that confirms the suitability of the lining material system for long-term immersion in each chemical to be stored. Service temperatures are expected to be up to 150 degrees F (65 degrees C).

- a) Neoprene Sheet Lining Material: Use a synthetic rubber formulated for steam curing at atmospheric pressure. Provide a minimum lining thickness of 3/16 inch. Supply B.F. Goodrich compound 59688, or equal.
 - b) Chlorobutyl Sheet Lining Material: Use a synthetic rubber formulated for steam curing at atmospheric pressure. Supply B.F. Goodrich compound 60924, or equal.
 - c) Natural Rubber (soft) Sheet Lining Material: Use a soft natural rubber formulated for steam curing at thickness at atmospheric pressure. Provide a minimum lining thickness of 3/16 inch. Supply B.F. Goodrich compound 83160, or equal.
 - d) Natural Rubber (hard) Sheet Lining Material: Use a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. Provide a minimum lining thickness of 3/16 inch. Supply B.F. Goodrich compound 8631, or equal.
 - e) EPDM Sheet Lining Material: Use synthetic rubber suitable for use as a lining for 50 percent sulphuric acid solution and formulated for autoclave or steam curing under pressure.
 - f) Hypalon Sheet Lining Material: Use synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution.
2. Primers: Use primers, adhesives, activators, accelerators, and other necessary materials as recommended by the sheet material manufacturer.
 3. Metal Surface Preparation: Prior to abrasive blast cleaning, prepare the base metal as required by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications, provide the highest degree of cleaning and surface preparation required by either instructions or specifications. Perform abrasive blast cleaning in accordance with this section.
 4. Installation: Install lining materials in accordance with the material manufacturer's written installation instructions. Line interior surfaces including piping, vents, fittings, flange faces, manhole covers, and blind

flanges.

5. Testing: Test the lining system for holidays in accordance with this Section before and after curing.
 6. Curing: Cure the lining system by steam using the time and temperature as required by the material manufacturer.
- G. System 105 – Vinyl Ester: Use vinyl ester resin coating material with an inert flake pigment. Coating shall be suitable for immersion service in 30 percent hydrochloric acid and 30 percent sulfuric acid solutions.
1. Coating (2 or more coats):
 - a) DFT = 40-45 mils (1000-1125 microns).
 - b) Products: Plasite 4100, or equal.
 - c) Prime Coat: As recommended by the material manufacturer.
- H. System 106 – 100 percent Solids Epoxy: Use an epoxy resin coating without solvent suitable for severe service areas subject to splash, spillage or intermittent immersion in wide range of industrial chemicals, and wastewater run-off. Coating shall be able to resist normal abrasion from rolling vehicles.
1. Coating (2 or more coats):
 - a) DFT = 15-20 mils (325-500 microns).
 - b) Products: Ameron, Carboline
 - c) Prime Coat: As recommended by manufacturer.
- I. System 107 – 100 percent solids Epoxy Sealer: Use a clear, unpigmented epoxy without solvent suitable for application over marginal surfaces including damp surfaces, tight rust and tight old coatings. Coating shall be able to serve as primer for alkyd, acrylic, epoxy, and polyurethane finish coats.
1. Coating (1 coat only):
 - a) DFT = 1-2 mils (25-50 microns).
 - b) Products: ICI/Devoe 167 PrePrime, Carboline Rust Bond, or equal.
- J. System 108 - 100 percent Solids, Isocyanate-Free, Solvent-Free, High Build Epoxy Coating for Wastewater applications only, to be spray applied in one or more coats

to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.

1. Product Characteristics:
 - a) Product: 100 percent solids, solvent-free high-build epoxy system
 - b) Product Type: amine cured epoxy
 - c) VOC Content (ASTM D3960): 0 percent
 - d) Compressive Strength, psi (ASTM D695): 10,500 (minimum)
 - e) Tensile Strength, psi (ASTM D638): 4,500 (minimum)
 - f) Flexural Strength, psi (ASTM D790): 7,500 (minimum)
 - g) Adhesion to Concrete, psi/mode of failure (ASTM D7234):

350 psi (minimum)/with substrate (concrete) failure
 - h) Chemical Resistance, pH $\geq$ 0.5 (ASTM G20): 60 percent Sulfuric Acid
2. In all cases the coating product(s) shall be applied to a minimum dry film thickness of 80 mils to surface profiles of CSP-4 to CSP-5 or 125 mils minimum DFT to surface profiles of CSP-6 or greater.
3. When the wall of the liner is to be structurally designed to withstand the hydraulic load generated by the groundwater table the long term (50yr) value of the flexural modulus of elasticity will be utilized to calculate the thickness of the structural line. The initial flexural modulus of elasticity (short term) of the submitted resin material will be utilized with the long term deformation percentage as determined by ASTM D2990 in the design equation outlined in ASTM 1216-09, Appendix XI. The value of the long term flexural modulus of the proposed product will be certified by an independent, certified, third party testing lab, independent of the Manufacturer. [The definition of long term value will be identified as initial flexural modulus of elasticity less the reduction in value caused by creep over a fifty (50) year minimum period and verified by third party testing (ASTM D2990).]
4. Subsequent top-coating or additional coats of the coating product(s) shall occur within the product recoat window or 24 hours whichever is less. Additional surface preparation procedures will be required if this recoat window is exceeded.

- K. System 109 - 100 percent Solids, Solvent-Free, Multi-Layered Polymer Lining System (Polyurea and Polyurethane) for Wastewater applications only, to be spray applied in three layers to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.
1. Product Characteristics:
 - a) Product: 100 percent solids, solvent-free, polyuria (two layers) and polyurethane (one layer) system
 - b) Product Type: Self-curing polymer lining
 - c) VOC Content (ASTM D3960): 0percent
 - d) Tensile Strength, psi (ASTM D412): 2,400 (minimum)
 - e) Elongation percent (ASTM D412): 200 (minimum)
 - f) Tear Strength, psi (ASTM D624): 300 (minimum)
 - g) Shore D Hardness, (ASTM 2240): 45 (minimum)
 - h) Adhesion to Concrete, psi/mode of failure (ASTM D7234): 350 psi (minimum)/with substrate (concrete) failure
 - i) Chemical Resistance, pH $\geq$ 0.5 (ASTM G20): 30percent Sulfuric Acid
 2. In all cases the coating product(s) shall be applied to a minimum thickness of 500 mils total.
 3. For resistance to ground water head pressure the coating shall be a minimum of 500 mils thick for depths up to 32 feet. For depths greater than 32 feet consult the coating manufacturer for recommendations.
 4. Subsequent top-coating or additional coats of the coating product(s) shall occur within the product recoat window or 24 hours whichever is less. Additional surface preparation procedures will be required if this recoat window is exceeded.
- L. System 110 – 100 percent Solids, High Build Polyurethane Coating for Wastewater applications, to be spray applied in one or more coats to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.
1. Product Characteristics:

- a) Product: 100 percent solids, high-build polyurethane system
 - b) Product Type: Catalyzed, two component, polyurethane
 - c) VOC Content (ASTM D3960): 0 percent
 - d) Compressive Strength, psi (ASTM D695): 18,000 (minimum)
 - e) Tensile Strength, psi (ASTM D638): 7,450 (minimum)
 - f) Flexural Strength, psi (ASTM D790): 14,000 (minimum)
 - g) Flexural Modulus, psi (ASTM D790): 735,000 (minimum)
 - h) Adhesion to Concrete, psi/mode of failure (ASTM D7234): 200 psi (minimum) with substrate (concrete) failure
 - i) Chemical Resistance, pH 0.5 (ASTM G20): 20 percent Sulfuric Acid
2. In all cases the coating product(s) shall be applied to a minimum dry film thickness of 80 mils to surface profiles of CSP-4 to CSP-5 or 125 mils minimum DFT or surface profiles of CSP-6 or greater.
3. When the wall of the resin based liner is to be structurally designed to withstand the hydraulic load generated by the groundwater table the long term (50yr) value of the flexural modulus of elasticity will be utilized to calculate the thickness of the structural line. The initial flexural modulus of elasticity (short term) of the submitted resin material will be utilized with the long term deformation percentage as determined by ASTM D2990 in the design equation outlined in ASTM 1216-09, Appendix XI. The value of the long term flexural modulus of the proposed product will be certified by an independent, certified, third party testing lab, independent of the Manufacturer. [The definition of long term value will be identified as initial flexural modulus of elasticity less the reduction in value caused by *Creep over a fifty (50) year minimum period and verified by third party testing (ASTM D2990).*]
4. Polyurethane product characteristics allow high build thicknesses to be achieved in one application without additional surface preparation. However, if installation requires applications outside of the recoat window, additional surface preparation may be necessary by using a primer or abrading the previously coating surface area.

PART 3 EXECUTION

3.1 MANUFACTURER'S SERVICES

- A. Require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support as may be necessary to resolve field problems attributable to or associated with manufacturer's products.
- B. For submerged and severe service coating systems, require the paint manufacturer to furnish the following services:
 - 1. At least 6 hours of on-site instruction on the proper surface preparation, use, mixing, application, and curing of the coating systems.
 - 2. Observe the start of surface preparation, mixing, and application and curing of the coating systems.
 - 3. Require the services of a NACE Certified Coating Inspector at all times during the surface preparation, mixing, application, curing and testing of all coatings applied in submerged or acid spill areas.

3.2 WORKMANSHIP

- A. Use skilled craftsmen and experienced supervision. For all jobs involving lead based paint removal or repair, require the presence of a certified Competent Person, Lead per OSHA requirements.
- B. Apply coating to produce an even film of uniform thickness. Give special attention to edges, corners, crevices, and joints. Ensure thorough cleaning and an adequate thickness of coating material. Apply coatings to produce finished surfaces free from runs, drips, ridges, waves, laps, brush marks, and variations in color, texture and finish. Effect complete hiding so that the addition of another coat would not increase the hiding. Give special attention to ensure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas. Apply a brushed stripe coat to all edges and welds after priming submerged or severe service areas.
- C. Remove, mask or otherwise protect hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, name plates on machinery, and other surfaces not to be painted. Provide drop cloths to prevent coating materials from falling on or marring adjacent surfaces. Protect the working parts of mechanical and electrical equipment from damage during surface preparation and coating operations. Mask openings in motors to prevent entry of coating or other materials.
- D. Do not damage adjacent work during blast cleaning operations. Conduct spray painting under carefully controlled conditions. Promptly repair any damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.
- E. Coordinate cleaning and coating so that dust and other contaminants from the

cleaning process will not fall on wet, newly-coated surfaces.

3.3 SURFACE PREPARATION STANDARDS

- A. The following referenced surface preparation standards of the Society for Protective Coatings (SSPC) form a part of this Specification:
1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces by cleaning with solvent, vapor degreasing, emulsion or alkaline cleaners, or steam.
 2. Hand Tool Cleaning (SSPC-SP2): Removal of all loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter by hand chipping, scraping, sanding, and wire brushing.
 3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by rotary or impact power tools, power wire brushing, or power abrading.
 4. White Metal Blast Cleaning (SSPC-SP5/NACE 1): Removal of all visible oil, grease, soil, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter by blast cleaning.
 5. Commercial Blast Cleaning (SSPC-SP6/NACE 3): Removal of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter, except that random staining shall be limited to no more than 33 percent of each unit area of surface.
 6. Brush-Off Blast Cleaning (SSPC-SP7/NACE 4): Removal of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose coating, all of which shall be considered tightly adherent if they cannot be removed by lifting with a dull putty knife.
 7. Near-white Blast Cleaning (SSPC-SP10/NACE 1): Removal of all visible oil, grease, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter, except that random staining shall be limited to no more than 5 percent of each unit area of surface.

3.4 METAL SURFACE PREPARATION(UNGALVANIZED)

- A. Provide the minimum abrasive-blasted surface preparation as indicated in the coating system schedules at the end of this Section. Where there is a conflict between these specifications and the coatings manufacturer's printed recommendations for the intended service, the higher degree of cleaning applies.

- B. Perform metal surface preparation in conformance with the current SSPC/NACE Standards and this Section. Blast cleaned surfaces must match standard samples in SSPC-VIZ 1.
- C. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning using solvent cleaning as per SSPC-SP1.
- D. Have sharp edges rounded or chamfered and burrs, surface defects, and welded splatter ground smooth prior to blast cleaning.
- E. Select the type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. As abrasives for submerged and severe service coating systems use clean, hard, sharp cutting crushed slag. Do not use automated blasting systems and metal shot or grit for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned with hard, sharp-cutting slag.
- F. Do not reuse abrasive except when an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, use clean, oil-free abrasives. In the abrasive mix use at least 50 percent steel grit. Replenish abrasive mix with new shot/grit combination as necessary to maintain the anchor profile within ½ mil (13 microns) of the specified profile.
- G. Comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.
- H. For air-blast cleaning, supply compressed air at adequate pressure from well-maintained compressors equipped with oil and moisture separators which delivers oil and water-free air as checked with white blotter, white cloth, or plastic sheets at the beginning of each blasting sequence.
- I. Clean surfaces of dust and residual particles of the cleaning operation using dry air-blast cleaning, vacuuming, or another approved method prior to painting. Vacuuming must be the final cleaning method immediately prior to painting areas that will go into submerged service.
- J. In enclosed areas and other areas where dust may settle, vacuum the surface clean and wipe it with a tack cloth.
- K. Remove damaged or defective coating by the specified blast or power tool cleaning to meet the clean surface requirements before recoating.
- L. If the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be in submerged service, then SSPC-SP2 – Hand Tool Cleaning or SSPC-SP3 – Power Tool Cleaning, may be used. If the coated area to be cleaned is less than 100 square feet,

and will be in submerged service, then SSPC-SP11 Power Tool Cleaning to Bare Metal may be used.

- M. Completely remove shop-applied coatings of unknown composition before the specified coatings are applied. Examine valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment for the presence of shop-applied temporary coatings. Completely remove temporary coatings by solvent cleaning per SSPC-SP1 method before starting abrasive blast cleaning. Alternate cleaning methods such as Baking Soda Blasting or Sponge Jet Blasting may be used as appropriate.
- N. Use the solvent cleaning method (SSPC-SP1) to clean shop-primed equipment in the field before finish coats are applied.

3.5 SURFACE PREPARATION FOR GALVANIZED FERROUS METAL

- A. For galvanized ferrous metal use the alkaline cleaning method per SSPC-SP1 to remove oil, grease, and other contaminants detrimental to adhesion of protective coatings. Alternate methods with biodegradable surfactant type cleaners followed by fresh water washing may be used as appropriate.
- B. Apply pretreatment coatings of surfaces in accordance with the printed recommendations of the coating manufacturer.

3.6 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS

- A. Preparatory Cleaning: Remove grease, oil, heavy chalk, dirt, or other contaminants by solvent or detergent cleaning prior to abrasive blast cleaning. Determine the generic type of the existing coatings by laboratory testing.
- B. Abrasive Blast Cleaning: Provide the degree of cleaning specified in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, remove deteriorated coatings by abrasive blast cleaning to meet the requirements of SSPC-SP6 Commercial Blast Cleaning. Clean areas of tightly adhering coatings to meet the requirements of SSPC-SP7 Brush-Off Blast Cleaning, with the remaining thickness of pre-existing coating not to exceed 3 mils.
- C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings, apply intermediate coatings conforming to the paint manufacturer's recommendation for the indicated coating system or completely remove the existing coating prior to abrasive blast cleaning. Make a small trial application for compatibility prior to painting large areas. Allow the trial application to cure for 7 days at 50 degrees F (10 degrees C) or higher before determining compatibility.
- D. Unknown Coatings: Completely remove coatings of unknown composition prior to application of new coatings.

- E. Water Jetting or Wet-abrasive Blast Cleaning: Where specified or where job site conditions do not permit dry-abrasive blasting for industrial coating systems due to dust or air pollution considerations, water jetting or wet-abrasive blasting may be used. In both methods, use inhibitors approved by the manufacturer of the coating system, which will be applied over the cleaned area. Begin the coating application as soon as the surface has dried, and before the formation of any flash rusting. Perform water jetting with or without abrasive injection, as appropriate to achieve the specified degree of surface cleanliness. Do not use water-jetting methods for submerged or severe-service coating systems, unless specified for that area.

3.7 PLASTIC, FIBERGLASS, AND NONFERROUS METALS SURFACE PREPARATION

- A. Unless otherwise indicated, for equipment, or parts of equipment which are not submerged in service, shop-prime them, and then finish-coat them in the field after installation. For methods, materials, application equipment, and other details of shop painting, comply with this Section. If the shop primer requires top coating within a specified period of time, apply the finish coating in the shop and then touch-up the paint after installation.
- B. Perform surface preparation and coating work in the field for equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves.
- C. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switch gear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the required quality in the field. For such equipment, prime and finish-coat in the shop and touch-up in the field after installation. Use the identical material for touch-up that was used for shop painting. Require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these specifications. Submit the coating material product data sheet with the shop drawings for the equipment.
- D. For certain small pieces of equipment, the manufacturer may have a standard coating system, which is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.
- E. Protect shop-painted surface during shipment and handling. Protect surfaces with padding or blocking. Lift equipment with canvas or nylon slings. Do not expose primed surface to the weather for more than 2 months before being top coated, or less time if recommended by the coating manufacturer.

- F. Repair damage to shop-applied coatings in accordance with this Section and the coating manufacturer's printed instructions.
- G. Make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Submit copies of applicable coating manufacturer's product data sheets with equipment shop drawings.

3.8 APPLICATION OF COATINGS

- A. Apply protective coatings to steel substrates in accordance with SSPC-PA1 – Paint Application Specification No. 1. Shop, Field and Maintenance Painting.
- B. Inspect cleaned surfaces and each coat prior to succeeding coats. Schedule inspections with the Engineer in advance.
- C. Paint blast-cleaned ferrous metal surfaces before rusting or other deterioration of the surface occurs. Limit blast cleaning to only those surfaces that can be coated in the same working day unless the area to be coated is protected by humidity control equipment set to maintain humidity below 50 percent at all times.
- D. Apply coatings in accordance with the manufacturer's instructions and this Section, whichever has the most stringent requirements.
- E. Give special attention to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thickness is likely to occur. Use stripe painting by brush, after application of the primer, for these areas.
- F. Give special attention to materials, which will be joined so closely that proper surface preparation and application are not possible. Coat such contact surface prior to assembly or installation. Only inorganic zinc primers may be used on faying surfaces.
- G. Apply finish coats, including touch-up and damage repair coats, in a manner, which will present uniform texture and color-matched appearance.
- H. Do not apply coatings under the following conditions:
 - 1. Temperature outside of the manufacturer's recommended minimum and maximum range.
 - 2. Dust or smoke laden atmosphere.
 - 3. When the substrate or air temperature is less than 5 degrees F (3 degrees C) above the dew point.

- 4. When air temperature is expected to drop below 40 degrees F (14 degrees C) or less than 5 degrees F (3 degrees C) above the dew point within 8 hours after application of the coating.
- 5. When wind conditions are in excess of 15 MPH or dust laden.
- I. Determine the dew point by use of a sling psychrometer in conjunction with the U.S. Department of Commerce, Weather Bureau psychrometric tables.
- J. For steel piping which will not be buried, have the surface abrasive blast cleaned and primed before installation.
- K. Apply finish coats after concrete, masonry, and equipment installation is complete and the work areas are clean and dust free. Concrete must have cured for a minimum of 28 days at 75 degrees F (24 degrees C) unless an approved epoxy sealer has been applied to green concrete within 12 hours of finishing the concrete.

3.9 CURING OF COATINGS

- A. Maintain curing conditions in accordance with the recommendations of the coating material manufacturer and this Section, whichever is the most stringent. Complete curing before placing the coating systems into service.
- B. In the case of enclosed areas, forced air ventilation using heated air may be required until the coatings have fully cured.
- C. Forced Air Ventilation of Enclosed Hydraulic Structures: Forced air ventilation is required for the application and curing of coatings on the interior surfaces of enclosed hydraulic structures. During application and curing periods, continuously exhaust air from the lowest level of the structure using portable ducting to force air into all compartments or around baffles of the structure. After interior coating operations have been completed, provide a final curing period that meets the minimum temperature and time requirements of the manufacturer of the coating system being applied, while operating the forced air ventilation system continuously.

3.10 SHOP AND FIELD INSPECTION AND TESTING

- A. Give the Authority Engineer a minimum of 3 days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.
- B. Perform surface preparation and coating applications in the presence of the Engineer, or his appointed NACE certified coating inspector, unless the Engineer has granted prior approval to perform the work in their absence.
- C. Inspection by the Engineer or the NACE certified inspector, or the waiver of

inspection of any particular portion of the work, does not relieve the Contractor of his responsibility to perform the Work in accordance with these Specifications.

- D. Erect and move scaffolding where requested by the Engineer to facilitate inspection. Provide additional illumination to light areas to be inspected. Remove or grind smooth all scaffolding clips welded to the structure prior to surface preparation of the structure.
- E. Until final acceptance of the coatings, furnish inspection devices in good working condition for the detection of holidays and measurement of dry-film thickness (DFT) of protective coatings. Make DFT gauges available for the Engineer's use while coating is being done, until final acceptance of such coatings. Provide the services of a NACE certified coating inspector for all holiday detection work until the final acceptance of such coatings. Operate holiday inspection devices in the presence of the Engineer.
- F. Perform holiday tests on coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Holiday tests shall be performed on surfaces coated with any of the submerged and severe service coating systems. Mark and repair or recoat areas which contain holidays in accordance with the coating manufacturer's printed instructions and then retest. **DO NOT PERFORM HOLIDAY TESTING AFTER STRUCTURE HAS BEEN SUBMERGED.**
 - 1. Coatings with Thickness Exceeding 20 mils (500 microns): For surfaces having a total DFT exceeding 20 mils (500 microns); use a pulse-type holiday Detector such as Elcometer 136, or equal. Adjust and operate in accordance with NACE RPO 188.
 - 2. Coatings with Thickness of 20 mils (500 microns) or Less: For surfaces having a total DFT of 20 mils or less, use Elcometer 269 non-destructive type holiday detector, or equal. Instrument must operate at less than 75 volts. For thicknesses between 10 and 20 mils (250 and 500 microns) and a non-sudsing type wetting agent such as Kodak Photo-Flo, or equal may be added to the water prior to wetting the detector sponge. For submerges or severe service areas, the residue of the wetting agent must be removed with clean, fresh water prior to application of any additional coats of the specified coating system.
- G. Film Thickness Testing: On ferrous metals, measure the DFT in accordance with SSPC-PA2 Measurement of Dry Film Thickness with magnetic gauges using either a pull-off type gauge (Elcometer 211) or constant pressure gauge (Elcometer 345F), or equal. Test each coat for the correct thickness. Calibrate the DFT gauge at the beginning of each workday or shift in accordance with the directions of the manufacturer of the gauge. Do not take measurements until at least 8 hours after coating application. On non-ferrous metals, measure the DFT with positive pressure

eddy current gages (Elcometer 345N) or equal.

- H. Surface Preparation: Evaluation of blast-cleaned surface preparation work will be based upon comparison with photographic samples contained in SSPC-VIZ 1. Evaluation of surface profile will be based upon the use of TesTex pressure sensitive tapes.

3.11 PAINTING AND IDENTIFICATION OF PIPING

A. Painting and Color Coding:

1. Use colors and signs to identify all piping which is exposed to view in buildings or tunnels, above suspended ceilings or exposed above grade, and all outdoor piping. Identify each pipe by a color complying with the following schedule of colors and by applied markers.
2. Coat pipes in the number of coats and type of material specified. Base coats for pipeline painting may be a neutral color. Make each succeeding base coat a contrasting color. For the final coat, comply with the pipe identifying color schedule.
3. Apply pipe identification markers to exposed piping, except for the following pipe at wastewater lift stations:
 - a) Discharge piping for wastewater pumps.
 - b) Vent piping.
 - c) Any piping inside wet wells.

B. Pipe Identification Markers:

1. Identify all pipes with applied signs or markers at 15-foot centers, at both sides of penetrated walls or floors, adjacent to valves, at connected equipment, at branch fittings, and in congested pipe layouts.
 - a) Apply markers consisting of signs with legends as follows:

OUTSIDE DIA. OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
3/4 to 1- 1/4	8	1/2
1- 1/2 to 2- 3/8	8	3/4
2- 1/2 to 5- 7/8	12	1- 1/4
6 to 7- 7/8	12	1- 1/4
8 to 10	24	2- 1/2

Over 10	32	3- 1/2

- b) As pipe markers use semi-rigid outdoor grade acrylic plastic, Seton Name Plate Corp. SetMark, or equal. Use Type SNA for outside diameters 3/4 through 5- 7/8 inches and Type STR for 6-inch outside diameter or larger. For pipes or pipe covering less than 3/4-inch in diameter, use applied marker of brass identification tags 1-1/2 inches square with depressed letters 1/4-inch high, black-filled. Apply tightly to pipeline with metal or plastic straps.

3.12 COATING SYSTEM SCHEDULES – FERROUS METALS

A. Coating System Scheduled, Ferrous Metal – Not Galvanized

SCHEDULE NO. AND APPLICATION	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTION
FM-1: Surfaces indoors and outdoors, exposed or covered, except those listed below.	Near White Metal blast cleaning SSPC-SP10/NACE 2	(2) Inorganic zinc/epoxy/polyurethane
FM-2: Surfaces in chlorination room, chlorine storage room, sodium hypochlorite storage room	Near White Metal blast cleaning SSPC-SP10/NACE 2	(100) Amine-cured epoxy
FM-3: Surfaces of pumps and equipment & other ferrous surfaces submerged or intermittently submerged in potable water, utility water, and wastewater, including surfaces lower than 2 feet above high-water level in hydraulic structures, and surfaces inside enclosed hydraulic structures, pump state wet wells, and vents (excluding shop-coated valves, couplings, and pumps).	White Metal Blast Cleaning SSPC-SP5/NACE 1	(100) Amine-cured epoxy
FM-4: Surfaces exposed to high temperature between 150 and 600 degrees F (65 and 315 degrees C).	Near White Metal blast cleaning SSPC-SP10/NACE 2	(3) Inorganic Zinc, water-based
FM-5: Surfaces exposed to high temperature between 600 and 1000 degrees F.	Near White Metal blast cleaning SSPC-SP10/NACE 2	(9) Aluminum silicon resin
FM-6: Where indicated, ferrous surfaces in water passages of valves 4-inch size and larger, exterior surfaces f submerged valves.	White Metal Blast Cleaning SSPC-SP5/NACE 1	(101) Polyamide-cured epoxy
FM-7: Where indicated, ferrous surfaces in water passages of pumps which have discharge size of 4 inches or larger; exterior, submerged surfaces of pumps.	White Metal Blast Cleaning SSPC-SP5/NACE 1	(101) Polyamide-cured epoxy

SCHEDULE NO. AND APPLICATION	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTION
FM-8: Ferrous surfaces of sleeve couplings.	White Metal Blast Cleaning SSPC-SP5/NACE 1	(103) Fusion-bonded epoxy
FM-9: Ferrous surfaces of sluice gates, flap gates, and shear gates, including wall thimbles.	White Metal Blast Cleaning SSPC-SP5/NACE 1	(101) Polyamide-cured epoxy
FM-10: Structural steel, miscellaneous metal work, and supports for prefabricated metal buildings, not exposed to view in finished building.	Commercial Blast Cleaning (SSPC-SP6/NACE 3	(10) Zinc Rich Epoxy
FM-12: Ferrous metal exposed to view, inside and outside of buildings.	Near White Metal blast cleaning SSPC-SP10/NACE 2	(2) Inorganic zinc/epoxy/polyurethane
FM-13: Surfaces of indoor equipment, not submerged.	Commercial Blast Cleaning SSPC-SP6/NACE 3	(5) Epoxy, equipment
FM14: Exterior (exposed) surfaces shop-coated with fusion-bonded epoxy.	Light abrasive blast to roughen surface	(6) Aliphatic polyurethane

- B. Coating System Schedule, Ferrous Metal – Galvanized: Apply pretreatment coatings, barrier coatings, or washes as recommended by the coating manufacturer.

SCHEDULE NO. AND APPLICATION	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTION
FMG-1: Exposed surfaces indoors and outdoors, except those listed below.	Alkaline cleaning SSPC-SP1	(1) or (4) Aliphatic Polyurethane, or Acrylic
FMG-2: Surfaces in chlorination room, chlorine storage room, and sodium hypochlorite storage room.	Alkaline Cleaning SSPC-SP1	(100) Amine-cured epoxy
FMG-3: Surfaces submerged in water or wastewater, including surfaces lower than 2 feet above high-water level and surfaces inside hydraulic structures and vents	Alkaline cleaning SSPC-SP1 followed by Brush-Off blast cleaning SSPC-SP7/NACE 4	(100) Amine-cured epoxy
FMG-4: Surface exposed to view, inside and outside of building.	Alkaline Cleaning SSPC-SP1	(1) or (4) Aliphatic polyurethane, or Acrylic

- C. Coating System Schedule, Interior Surface of Welded Steel Tanks: Coat interior surfaces, including tank nozzles, manholes, nozzle necks, and flange faces. For steel tank exterior coating systems, see paragraph 3.15.1, Coating System Schedule, Ferrous Metal – Not Galvanized.

PRODUCT STORED	SURFACE PREPARATION	SYSTEM NO. /DESCRIPTION
Zinc Orthophosphate	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Liquid Alum	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Polymer	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Sodium Bisulfite	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Ferric Chloride	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (hard)
Aqueous Ammonia	White metal blast cleaning SSPC-SP5/NACE1	(104) Chlorobutyl rubber
Caustic Soda	Commercial Blast Cleaning SSPC-SP6/NACE 3	No Coating
Sodium Hypochlorite	White metal blast cleaning SSPC-SP5/NACE1	(104) Chlorobutyl Rubber
Sulfuric Acid (max. 45 percent concentration)	White metal blast cleaning SSPC-SP5/NACE1	(107) Hypalon
Sulfuric Acid (above 40 percent concentration)	White metal blast cleaning SSPC-SP5/NACE1	(107) Viton
Hydrofluosilicic Acid	White metal blast cleaning SSPC-SP5/NACE1	(107) Chlorobutyl Rubber
Water, Potable Water, Utility Water	White metal blast cleaning SSPC-SP5/NACE1	(100) Amine-Cured Epoxy

3.13 COATING SYSTEM SCHEDULES, NONFERROUS METAL, PLASTIC, FIBERGLASS

- A. Where isolated non-ferrous parts are associated with equipment or piping, use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames, or hatches. Use primers recommended by coating manufacturer.

SCHEDULE NO. AND APPLICATIONS	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTION
NFM-1: Exposed surfaces, indoors and outdoors, except those listed below.	Solvent cleaned SSPC-SP1	(1) Aliphatic Polyurethane

NFM-2: Chlorination room, chlorine storage room, sodium hypochlorite storage room.	Solvent cleaned SSPC-SP1	(100) Amine-Cured Epoxy
NFM-3: Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC-SP1	(8) Aluminum Metal Isolation
NFM-4: polyvinyl chloride plastic, indoors and outdoors, not submerged.	Solvent cleaned SSPC-SP1	(4) Acrylic
NFM-5: Fiberglass surfaces.	Per paragraph 3.09, Plastic, Fiberglass, and Non-Ferrous Metals Surface Preparation	(6) Aliphatic Polyurethane Fiberglass

END OF SECTION

SECTION 13110
CATHODIC PROTECTION SYSTEM

PART 1 - GENERAL

1.1 THIS SECTION INCLUDES

- A. The WORK of this Section includes providing a complete cathodic protection (CP) system associated with the West Harris County Regional Water Authority (WHCRWA) and North Fort Bend Water Authority (NFBWA) Surface Water Supply Project Segment C as outlined in this Section and on the Drawings:
 - 1. Pipeline including 84-inch, 66-inch and 36-inch diameters beginning at Segment C and ending at station 901+60
- B. Electrical isolation of the structures from adjacent metallic structures, steel reinforced concrete structures, casings, structures of dissimilar metal or dissimilar coatings, conduits, and all other metallic components that may impact the operation of the CP system.
- C. Electrical bonding of all non-insulated, non-welded pipe joints and mechanical joints.
- D. Installation of rectifiers, anode beds, insulating joints, test stations, other components associated with the CP system, and all other work described herein and on the Drawings.
- E. Provision of electrical power for rectifiers, including any easements, permits, trenching, conduits, services meters, and other items as required. Not all required items are shown on the Drawings.
- F. Installation of galvanic anodes, insulating joints, test stations, other components associated with the CP system, and all other work described herein and on the Drawings.
- G. Testing of CP system during installation.
- H. Cleanup and restoration of work site.
- I. Final System Checkout: Testing of CP system after installation and backfill.

1.2 REQUIREMENTS

- A. If the products installed as part of this Section are found to be defective or damaged or if the WORK of this Section is not in conformance with these Specifications, then the products and WORK shall be corrected at the CONTRACTOR's expense.
- B. Any retesting required due to inadequate installation or defective materials shall be paid for by the CONTRACTOR at no additional cost to the owner.
- C. The WORK also requires that one Supplier or Subcontractor accept responsibility for the WORK, as indicated, but without altering or modifying the CONTRACTOR's responsibilities under the Contract Documents.

- D. The WORK also requires coordination of assembly, installation, and testing between the pipeline contractor and any CP material supplier or subcontractor.
- E. All electrical WORK shall be in accordance with NEC and local requirements.

1.3 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - 1. General Requirements
 - 2. Site Work
 - 3. Concrete
 - 4. Finishes
 - 5. Electrical

1.4 REFERENCED SPECIFICATIONS, CODES AND STANDARDS

- A. The WORK of this Section shall comply with the current editions of the codes and standards referenced in this specification, including the following:
 - 1. AASHTO American Association of State Highway and Transportation Officials
 - a. H20 Specification for Highway Bridges
 - 2. ASTM ASTM International
 - a. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - b. A518 Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
 - c. A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - d. B3 Standard Specification for Soft or Annealed Copper Wire
 - e. B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - f. B80 Standard Specification for Magnesium-Alloy Sand Castings

- g. B187 Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
- h. B418 Standard Specification for Cast and Wrought Galvanic Zinc Anodes
- i. B843 Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
- j. C94 Standard Specification for Ready-Mixed Concrete
- k. D1000 Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
- l. D1248 Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
- m. D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- n. D2220 Standard Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 75°C Operation
- o. D3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- p. D4388 Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes
- q. D6386 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
- r. G97 Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications
- 3. AWWA American Water Works Association
 - a. C217 Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
- 4. NSF National Sanitation Foundation
 - a. NSF 61 Drinking Water System Components
- 5. NACE International, the Corrosion Society
 - a. RP0193 External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms

- b. RP0375 Field-Applied Underground Wax Coating Systems for Underground Pipelines: Application, Performance, and Quality Control
- c. SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- d. SP0196 Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks
- e. SP0286 Electrical Insulation of Cathodically Protected Pipelines
- f. SP0388 Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks
- g. SP0572 Design, Installation, Operation and Maintenance of Impressed Current Deep Anode Beds
- h. TM0497 Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems
- 6. NFPA National Fire Protection Association
 - a. NFPA 70 National Electric Code (NEC)
- 7. NEMA National Electrical Manufacturers Association
 - a. 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)
 - b. TC2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
 - c. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
- 8. UL Underwriters Laboratories
 - a. 6 Rigid Metal Conduits
 - b. 467 Grounding and Bonding Equipment
 - c. 506 Standard for Specialty Transformers
 - d. 514B Fittings for Cable and Conduit
- B. Whenever the Drawings or these Specifications require a higher degree of workmanship or better quality of material than indicated in the above codes and standards, these Drawings and Specifications shall prevail.

1.5 PERMITS AND JOB ACCESS

- A. Prior to the start of construction, the CONTRACTOR shall apply to the required authorities for permits required for installation of the CP system.
- B. The CONTRACTOR shall contact Underground Service Alert prior to commencing construction to locate existing utilities in the area of construction. Existing utilities include, but are not limited to, water lines, gas lines, telephone, street lights, sewer and storm drains and overhead and underground electric utilities.
- C. If traffic control is necessary, it shall satisfy the requirements of the governing locality.
- D. The CONTRACTOR shall be responsible for reviewing the rectifier locations to determine whether there are any conflicts with obtaining power at the indicated locations. The CONTRACTOR shall report any conflicts to the ENGINEER prior to proceeding with the Work.
- E. The CONTRACTOR shall submit an application to the local power company for AC power to the new rectifiers. The CONTRACTOR shall be responsible for all fees and expenses (including easements) associated with providing power to the rectifiers.

1.6 QUALITY ASSURANCE

- A. Installation of the CP equipment shall be performed by individuals having at least five years of experience in the installation of the CP equipment described herein.
- B. All testing required completed by Contractor to be performed by a “Corrosion Technician” shall be performed by a NACE certified Corrosion Technician under the supervision of a Corrosion Engineer hired by the Contractor. A Corrosion Technician is a NACE CP2 (CP Technician), CP3 (CP Technologist), or CP4 (CP Specialist). A Corrosion Engineer is a Registered Professional Corrosion Engineer or a NACE CP4 (CP Specialist).
- C. All well drilling shall be performed by a Texas licensed Well Drilling CONTRACTOR.
- D. All deep well installations shall be installed in accordance with the applicable sections on wells from local regulations.

1.7 SUBMITTALS

- A. The following shall be submitted to the ENGINEER prior to any equipment installation.
 - 1. Catalog cuts, bulletins, brochures, or data sheets for all materials specified herein.
 - 2. Statement that the equipment and materials proposed meet the Specifications and the intent of the Specifications.
 - 3. Statement of installation experience required.
 - 4. Schedule, including the expected start date and planned completion date.

5. Copy of well drilling or surface disturbance permits, if permit(s) are required by local jurisdiction.
 6. Description of power system to be provided for rectifiers, including cut sheets, meter sizing, power company requirements, and copy of permits.
- B. The following shall be submitted to the ENGINEER after completion of the WORK.
1. Wire connection testing.
 2. Insulating joint testing, before and after backfill.
 3. Casing insulator testing, before and after backfill.
 4. Joint bond testing, before and after backfill.
 5. Well completion report.
 6. Electrical log with anode-to-earth resistances.
 7. Final System Checkout Report.
 8. Record Drawings shall be submitted to and approved by the ENGINEER before the WORK is considered complete.
- C. The following shall be included in the Owner's Manual:
1. Operations and maintenance (O&M) manual with instructions for CP system and components. O&M manual may include rectifier operations and instructions for adjustments, CP measurements at recommended frequencies, and testing documentation guidelines.
 2. List of spare parts recommended for two years of successful operation.

1.8 INTERFERENCE AND EXACT LOCATIONS

- A. The locations of CP equipment, test stations, devices, outlets, and appurtenances, as indicated are approximate only. Exact locations shall be determined by the CONTRACTOR in the field subject to the approval of the ENGINEER.
- B. The CONTRACTOR shall field verify all data and final locations of work done under other Sections of the Specifications required for placing of the electrical work.
- C. In case of interference with other work, foreign pipeline, or erroneous locations with respect to equipment or structures, the CONTRACTOR shall furnish all labor and materials necessary to complete the WORK in an acceptable manner to the OWNER. Deviations from the Drawings and Specifications shall be submitted to the OWNER for approval.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials installed must be new. All equipment and materials supplied shall be similar to that which has been in satisfactory service for at least 5 years.

2.2 RECTIFIERS

- A. Rectifiers shall be air-cooled, single-phase, 115/230 V_{AC} input, with DC voltage and current output ratings as indicated on the drawing rectifier schedule. Rectifiers shall be manufactured by Universal Rectifiers, Corpro, JA Electronics, or an approved equivalent.
- B. Rectifiers shall be designed to operate continuously at an ambient temperature of 50°C without damage to the rectifier components.
- C. Transformer: Two-winding, insulating type that meets the requirements of NEMA and UL 506.
- D. Rectifiers shall be capable of operating continuously at the rated output current at any voltage from zero to 100% without damaging any rectifier components. Full-rated DC output voltage shall be adjustable by not less than 25 equal steps from approximately 4% of rated voltage to full rated output voltage. This adjustment shall be accomplished with silver-plated or stainless steel connectors and adjustment link bars.
- E. Rectifying element shall be a full-wave bridge, silicon diode stack with efficiency filter, metal oxide thyristors, and current-limiting devices for overvoltage and overcurrent protection of stack. Silicon stacks shall be equipped with silicon diodes rated at a minimum of 1,000 peak inverse volts.
- F. All rectifiers shall have overload and lightning protection for both AC and DC circuits.
- G. A voltmeter and ammeter shall be provided. Voltmeter and ammeter shall be calibrated and adjusted at the factory.
- H. Electrical tests shall be performed by the manufacturer and recorded as listed below:
 - 1. AC Volts Input
 - 2. DC Amperes Input
 - 3. Apparent Watts Input
 - 4. True Watts Input
 - 5. Power Factor
 - 6. DC Volts Output
 - 7. DC Amperes Output
 - 8. DC Watts Output
 - 9. Conversion Efficiency
 - 10. Dielectric Strength
 - 11. Transformer Primary to Ground
 - 12. Transformer Secondary to Ground
 - 13. Transformer Primary to Secondary

14. Stack AC to Ground
15. Stack DC to Ground
16. Ripple Voltage at Full Output

- I. The following shall be provided for each rectifier. Each item shall be provided in a waterproof bag or container.
 1. Operations and Maintenance Manual
 2. Circuit Diagram
 3. Electrical Test Report

2.3 RECTIFIER CABINETS

- A. Rectifier cabinets shall be NEMA 250 Type 3R and sized as shown on the Drawings.
- B. Rectifier cabinets shall be made of 316 stainless steel.
- C. Cabinets shall have a single door with a full length hinge and a lockable latch. Hinge, latch, and other miscellaneous metallic components on the cabinet shall be 316 stainless steel.
- D. Rectifiers shall be equipped with permanent identification tags affixed to the outside front door. The identification tag shall have white engraving for identification of the rectifier. Minimum height of lettering shall be 3/4 inch. The tags shall have the following legend:

WEST HARRIS COUNTY REGIONAL WATER AUTHORITY AND NORTH FORT BEND WATER
AUTHORITY

SURFACE WATER SUPPLY PROJECT/STATION NUMBER

CATHODIC PROTECTION RECTIFIER

- E. HSCI anodes shall meet the requirements of ASTM A518 Grade 3. Anodes shall be manufactured by Anotec, Corrpro, or equivalent.
- F. HSCI anodes shall be tubular type anodes with centered wire connection. Anodes shall have the following size, form, and shape based on the anode type identified in the rectifier/anode bed schedule on the drawings.

Anode Type	Length (inch)	Diameter (inch)	Weight (lb)	Surface Area (ft ²)
2260Z or TACD	60	2 to 2.2	32 to 36	2.8 to 2.9
2284Z or TA2	84	2 to 2.2	46 to 50	4.0
2660Z or TAD	60	2 to 2.7	45 to 50	3.5
2684Z or TA3	84	2 to 2.7	63 to 70	4.9
3860Z	60	2.9	62	3.8
3884Z	84	2.9	90	5.3

G. Anode lead wire:

1. The wire attached to the anodes shall be of the size and type indicated on the Drawings. The anode lead wire shall conform to the specifications given for "Wires" in this specification.
2. The wire shall be connected to the interior of the anode and sealed by the manufacturer. The anode wire connection shall have a pulling strength exceeding the wire's tensile strength. Any damage to the wire insulation or anode shall require complete replacement of the wire and anode.
3. Anode lead wires shall be of one continuous length, without splices, unless otherwise indicated on the Drawings, from the anode connection to the anode terminal board. Anode wires with the attached anodes shall be shipped to the job site with the wire wound on a reel. The minimum core diameter of the reel shall be 5 1/2 inches. The anode wire insulation shall be free of surface damage such as nicks, abrasions, scratches, etc., in all respects throughout the entire length of the wire. Precautions shall be taken during fabrication, transportation, and installation of the anodes to see that the wire is not kinked or sharply bent. Bends sharper than 2 1/2 inches in radius are not permissible.

H. The resistance of each anode wire connection shall not exceed 0.004 ohms. Each anode wire connection should be tested by the manufacturer for conformance with these Specifications. A record of tests shall be submitted to the ENGINEER. The records shall include a minimum of three copies of the following information:

1. Anode numbering system to identify anode under test
2. Anode wire length
3. Resistance value, as indicated by test
4. Test equipment
5. Test method

I. Anodes shall be individually labeled with the length of lead wire and anode number. Anodes shall be consecutively numbered with the deepest anode being Number 1.

2.4 GALVANIC ANODES

- A. High-potential magnesium anodes: Cast magnesium anodes shall conform to ASTM B843 Type M1C. Anodes shall have an open circuit potential of -1.70 volts or more electronegative and a current efficiency of at least 48% when tested in accordance with ASTM G97. Anodes shall have the following size, form, and shape. Anodes shall be manufactured by Farwest, Corrpro, Mesa, Matcor, or equivalent.

Ingot				Packaged		
Weight (lb)	Width (inch)	Height (inch)	Length (inch)	Weight (lb)	Diameter (inch)	Length (inch)
60	4 to 5	4	60	126 to 130	6 to 7	64

- B. Galvanic anodes shall be pre-packaged in a cloth bag containing backfill of the following composition: 75% gypsum, 20% bentonite, and 5% sodium sulfate. The anodes shall be of the size indicated on the Drawings and placed where indicated on the Drawings.
- C. Anode lead wire:
 - 1. The wire attached to the anodes shall be of the size and type indicated on the Drawings. The anode lead wire shall conform to the specifications given for “Wires” in this specification.
 - 2. Connection of wire to the anode shall have a pulling strength that exceeds the wire’s tensile strength.
 - 3. Anode lead wires shall be of one continuous length, without splices, unless otherwise indicated on the Drawings, from the anode connection to the test station.

2.5 CALCINED COKE BREEZE

- A. Backfill material for impressed current anodes shall be calcined coke breeze.
- B. Calcined coke breeze shall have a resistivity of 25 ohm-cm or less when tested with an applied pressure of 2 psi and a bulk density of 64 to 74 pounds per cubic foot. The particle size shall be between 200 mesh and 18 mesh and shall be dust free. The minimum calcination temperature of base materials shall be 1250 °C.
- C. Calcined coke breeze shall have the following chemical properties:
 - 1. Fixed carbon 98% minimum
 - 2. Ash 0.6% maximum
 - 3. Volatile matter 1.0% maximum
 - 4. Moisture 1.0% maximum
- D. Calcined coke breeze shall be Loresco SC-3, Asbury 251, or approved equivalent when installed by pumping down the hole. If installed via the freefall method, calcined coke breeze shall be Loresco RS-3, Ashbury 218-L, or equivalent.

2.6 ANODE VENT PIPING

- A. Anode vent piping for the impressed current anode vent piping shall be 2-inch diameter PVC, Schedule 80, conforming to ASTM D1785 Type 1 Grade 1.
- B. Slots and perforations shall be provided in the immediate vicinity of the anodes and throughout the coke breeze and sized such that coke breeze does not enter vent pipe. The vent pipe shall be capped at both ends during the backfilling operation to mitigate infiltration of backfill material or mud.
- C. Above ground portions of anode vent piping shall be rated for sunlight resistance.

- D. Above ground outlet for vent piping shall have a vent screen with an orientation preventing rainfall accumulation and bug intrusion.

2.7 ANODE CENTRALIZERS

- A. Centering devices shall be designed and fabricated by the CONTRACTOR or Supplier and shall be submitted to the ENGINEER for acceptance prior to use. The device shall be constructed of metal.

2.8 READY-MIXED CONCRETE

- A. Ready-mixed concrete shall be in accordance with ASTM C94, permit requirements, and the Specification section for cast-in-place concrete.

2.9 REINFORCING STEEL

- A. Reinforcing steel shall be in accordance with ASTM A615, permit requirements, and the Specification section for reinforcing steel.

2.10 FLUSH-MOUNTED TEST STATION

- A. Flush-mounted test station boxes shall be traffic boxes rated to withstand AASHTO H20 traffic loading.
- B. The traffic boxes shall be G05 Utility Boxes, as manufactured by Christy Concrete Products, Inc.; No. 3RT Utility Box, as manufactured by Brooks Products; or an approved equivalent.
- C. The traffic boxes shall be B1017, as manufactured by Christy Concrete Products, or an approved equivalent.
- D. Traffic box covers for test stations shall be cast iron with welded bead legend and labeled "CP TEST" or "ANODE," as required.

2.11 TERMINAL BOARDS

- A. Terminal boards shall be made of 1/4-inch thick phenolic plastic and sized as indicated on the Drawings.
- B. Connection hardware shall be brass or bronze. All connections shall be double nutted bolts with serrated lock washers.
- C. Copper bus bar shall be 1/8-inch thick and sized to fit. The copper bus bar shall be per ASTM B187 with 98% conductivity.

2.12 MECHANICAL LUGS

- A. Mechanical lugs shall be brass or copper with a brass, copper, or stainless steel set screw. Tin plating on the lugs is optional. Aluminum lugs shall not be permitted. Zinc-plated steel set screws shall not be permitted. The lug shall be listed per UL 467, suitable for direct burial, and appropriately sized for the incoming wires. The lug shall be ILSCO Type XT-6DB, Burndy GKA8C, or an approved equivalent.

2.13 SHUNTS

- A. Shunts shall be the selected by the size indicated on the Drawings.
- B. 0.01-ohm, 6-amp shunts shall be manganin wire type, as indicated. Shunts shall be Type RS, as manufactured by Holloway, or equivalent.
- C. 0.001-ohm, 25-amp shunts shall be Type SS, as manufactured by Holloway, or equivalent.

2.14 CONDUIT AND FITTINGS

- A. The minimum conduit size shall be 1 inch unless otherwise indicated. Refer to NFPA 70 (NEC) for additional conduit size requirements.
- B. Conduit and fittings placed below grade shall be Schedule 80 PVC in accordance with NEMA TC2 and NEMA TC3.
- C. Conduit and fittings placed above grade shall be rigid steel. Rigid Steel conduit shall be galvanized and conform to UL 6.
- D. Conduit clamps shall be galvanized steel, 304 stainless steel, or 316 stainless steel.
- E. Fittings for use with rigid steel conduit shall be galvanized cast ferrous metal, with gasketed covers, Crouse Hinds Condulets, Appleton Unilets, or equivalent. Rigid metallic conduit fittings shall be galvanized, conform to NEMA FB 1, and listed to UL 514B.
- F. Union couplings for conduit shall be Erickson or Appleton Type EC, 0-Z Gedney 3-piece Series 4, or equivalent.

2.15 CAUTION TAPE

- A. The caution tape shall be an inert plastic film designed for prolonged underground use. The caution tape shall be a minimum of 3 inches wide and a minimum of 4 mils thick.
- B. The caution tape shall be continuously printed over the entire length with the wording "CAUTION: CATHODIC PROTECTION CABLE BURIED BELOW."
- C. The wording shall be printed using bold black letters. The color of the tape shall be red.

2.16 WIRES

- A. Conductors shall consist of stranded copper of the gauge indicated on the Drawings. Wire sizes shall be based on American Wire Gauge (AWG). Copper wire shall be in conformance with ASTM B3 and ASTM B8.
- B. Insulation Type and Colors: As shown on the Drawings.
 - 1. High molecular weight polyethylene (HMWPE) wires shall be rated for 600 volts and shall conform to ASTM D1248, Type 1, Class C, Grade 5.
 - 2. Halar/HMWPE wires (CP wire) shall be rated for 600 volts and have dual insulation. The primary layer of insulation shall be a homogeneous 20 mil wall of ECTFE fluoropolymer (Halar), and the jacket shall be a 65 mil wall of HMWPE conforming to ASTM D1248, Type 1, Class C, Grade 5. Halar/HMWPE wire shall be UL listed as Cathodic Protection Wire.
 - 3. RHW wires shall be UL listed and marked as RHW or RHW-2 and rated for 600 volts. RHW wires shall have crosslinked polyethylene (XLPE) insulation that conforms with ASTM D1248.

2.17 WIRE IDENTIFICATION TAGS

- A. Wire identification tags shall be the wrap-around type with a high resistance to oils, solvents, and mild acids. Wrap-around markers shall fully encircle the wire with imprinted alpha-numeric characters for pipe identification. The letters and numbers height shall be 3/16 inch at minimum.

2.18 EXOTHERMIC WELDS

- A. Exothermic welds shall be in accordance with the manufacturer's recommendations. Exothermic welds shall be Cadweld manufactured by Erico, Thermoweld manufactured by Burndy, or an approved equivalent.
- B. Prevent molten weld metal from leaking out of the mold, where necessary, by using Duxseal packing manufactured by Johns-Manville, Thermoweld packing material manufactured by Burndy, Cadweld T403 Mold Sealer manufactured by Erico, or an approved equivalent.
- C. The shape and charge of the exothermic weld shall be chosen based on the following parameters:
 - 1. Pipe material
 - 2. Pipe size
 - 3. Wire size and requirement for sleeves
 - 4. Number of wires to be welded
 - 5. Orientation of weld (vertical or horizontal)

2.19 EXOTHERMIC WELD COATING

- A. After exothermic welding, repair coatings and linings in accordance with the coating and lining manufacturer's recommendation.

- B. For cement mortar lined and coated (CMLC) steel pipe, coating material for exothermic weld connections to the pipelines shall be two part ProPoxy 20 epoxy putty manufactured by the Hercules Chemical Company, Repair Putty Multi-Purpose by Loctite, or an approved equivalent. The epoxy putty shall be non-conductive and have at least 300 volts per mil of dielectric strength. The epoxy putty shall be covered with mortar to match the pipe coating.
- C. For bare steel, dielectrically coated steel, or ductile iron pipe, weld caps with integrated primer shall be used to cover the exothermic weld connecting the wire to the pipe. The weld cap shall be a 10-mil thick durable plastic sheet that has a dome filled with a moldable compound to assure complete encapsulation of the exothermic weld and a layer of elastomeric adhesive with integrated primer. The adhesive and primer shall be compatible with the pipe material and pipe coating material. Adhesion to steel shall be at least 10 lb/in per ASTM D1000. Weld cap with integrated primer shall be Handy Cap IP manufactured by Royston or equivalent for wire size up to 8 AWG and Handy Cap XL IP manufactured by Royston or equivalent for wire size up to 2 AWG.

2.20 DIELECTRIC INSULATING FLANGE KITS

- A. Insulating flange kits shall include full-faced gaskets, insulating sleeves and washers, and 316 stainless steel bolts, nuts, and washers. The complete assembly shall have a pressure rating equal to or greater than the flanges between which it is installed. Sleeves, gaskets, and insulating washers shall have a minimum dielectric constant of 300 volts per mil. Stainless steel washers shall fit well within the bolt facing on the flange. Insulating washers shall fit within the bolt facing the flange over the outside diameter of the sleeve.
 - 1. Insulating gasket shall be full-faced, Type E, and 1/8-inch thick. Acceptable gasket materials include nitrile faced phenolic, G-10, or a material with equivalent or increased performance. Acceptable seal materials include EPDM, PTFE, or a material with equivalent or increased performance. When used in potable water systems, gasket and seal shall be NSF 61 approved.
 - 2. Insulating sleeves shall be 1/32-inch thick and equal the number of bolts on the flange. Acceptable materials include Mylar, G-10, or a material with equivalent or increased performance.
 - 3. Insulating washers shall be 1/8-inch thick and equal to twice the number of bolts on the flange. Acceptable materials include G-10 or a material with equivalent or increased performance.
- B. Dielectric insulating flange kits shall be manufactured by Advance Products & Systems Inc., GPT Industries, or an approved equivalent.

2.21 MONOLITHIC INSULATING JOINTS

- A. Monolithic insulating joints shall be designed to provide for the electrical isolation of piping sections and shall be completely factory assembled. Monolithic insulating joints shall be designed so that they are welded into the field piping during installation.
- B. Monolithic insulating joints shall have the same or better pressure rating and hydrostatic performance as the pipeline where it will be installed.

- C. The electrical resistance in dry air shall be greater than or equal to 5 MΩ at 1000 V_{DC}. The breakdown voltage in dry air shall be at least 3 kV_{AC} at 50 Hz for 1 minute.
- D. When used in potable water systems, the internal coating shall be NSF approved.
- E. Monolithic insulating joints shall be manufactured by Advance Products & Systems Inc., GPT Industries, or an approved equivalent.

2.22 CASING END SEAL

- A. Casing end seal shall seal the annular space between the carrier pipe and casing. A casing end seal shall be installed on each end of the casing. The casing end seal shall be designed to last the life of the piping system.
- B. Casing end seal shall be at least 1/8-inch thick neoprene, nitrile, or EPDM. The seal shall be secured with 316 stainless steel banding straps or approved equal

2.23 GROUT

- A. The annular space between the carrier pipe and casing shall be filled with grout when required. Grout shall be in accordance with the Specification section for grouts.

2.24 PETROLATUM WAX TAPE

- A. Petrolatum wax tape shall meet or exceed the requirements of AWWA C217 and shall consist of three parts: Surface primer, wax tape, and outer covering. All three parts shall be the product of a single manufacturer.
- B. The primer shall be a blend of petrolatums, plasticizers, and corrosion inhibitors having a paste-like consistency. Primer shall be Wax-Tape Primer manufactured by Trenton, Denso Paste manufactured by Denso, or approved equivalent.
- C. The wax tape shall be synthetic-fiber felt, 45 to 90 mils thick, saturated with a blend of micro-crystalline wax, petrolatums, plasticizers, and corrosion inhibitors that is capable of easy conformability over irregular surfaces. Wax tape shall be #1 Wax-Tape manufactured by Trenton, Denso Tape manufactured by Denso, or approved equivalent.
- D. The outer covering shall be a plastic wrap consisting of one 150-gauge sheet or three 50-gauge sheets wound together as a single sheet, clear polyvinylidene chloride, shrink wrap that is flexible enough to conform to irregular surfaces. Outer wrapping shall be Poly-Ply by Trenton, Poly-Wrap by Denso, or approved equivalent.

2.25 WATERPROOF SPLICE KIT

- A. Splice kit shall be a resin splice kit that completely encapsulates the wire and splice connection and shall be designed for CP splices. Splice kit shall be Scotchcast 85-14 CP Resin Splicing Kit, as manufactured by 3M, or an approved equivalent.

2.26 RUBBER SPLICING TAPE

- A. Rubber splicing tape shall meet the requirements of ASTM D4388 with a minimum thickness of 30 mils. Tape shall be Scotch Brand linerless rubber splicing tape, Model 130C, as manufactured by 3M, or an approved equal.

2.27 ELECTRICAL TAPE

- A. Vinyl electrical tape shall meet the requirements of ASTM D3005 with a minimum thickness of 8.5 mils. Electrical tape shall be Scotch Brand Premium Vinyl Electrical Tape, Model Super 88, as manufactured by 3M, or an approved equivalent.

2.28 ANODE HEADER WIRE-TO-ANODE LEAD WIRE SPLICE

- A. The connection between the anode header wire and the anode lead wire shall be a copper split bolt or copper crimp.
- B. The connection shall be covered with a minimum of 2 layers of half lapped rubber splicing tape and 2 layers of half lapped PVC electrical tape on top of the rubber tape.

2.29 ISOLATION MAT

- A. Isolation mat shall be neoprene and of the dimensions shown on the Drawing.

PART 3 - EXECUTION

3.1 MATERIAL AND EQUIPMENT STORAGE

- A. All materials and equipment to be used in construction shall be stored in such a manner to be protected from detrimental effects from the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or another method, as appropriate.

3.2 EXCAVATION AND BACKFILL

- A. Buried wires shall have a minimum cover of 24 inches.
- B. Caution tape shall be installed above buried wire. Caution tape shall be installed a minimum of 6 inches above underground wires and conduits.
- C. Anode wire identification tags shall be placed on the wires prior to placing wire in conduit or backfilling.

3.3 RECTIFIER

- A. Approximate rectifier locations are shown on the Drawings. The CONTRACTOR may propose an alternative rectifier location to the WHCRWA/NFBWA representative for review and approval.

- B. Rectifier installation includes provision of AC power to the rectifier by the CONTRACTOR. CONTRACTOR shall furnish and install all required wiring, conduits, wires, meters, splice boxes, and equipment necessary for operation of the rectifier and as required by the local power agency.
- C. The reinforced concrete pad shall be constructed such that water will not collect against the rectifier cabinet. The concrete pad shall extend a minimum of 2 inches above grade. The vent pipe riser and conduits into the enclosure shall be cast into the concrete pad. After the concrete is set, the enclosure shall be securely anchored to the pad with expanding anchor bolts. Use leveling nuts below the cabinet flange to create space for the grout seal. Apply the non-shrink grout as shown on the Drawings.

3.4 DEEP ANODE WELL

- A. Impressed current anode beds shall be installed in accordance with NACE SP0572, local well standards, and these Specifications.
- B. Well Drilling
 - 1. The CONTRACTOR shall obtain and pay for all fees and permits required for well drilling. CONTRACTOR shall log the well in accordance with local and state agency requirements.
 - 2. The CONTRACTOR shall protect the well bore from the intrusion of contaminants into the hole at all times. The CONTRACTOR is responsible for the cost of all cleanup associated with contamination of the well and/or job site resulting from the CONTRACTOR's WORK.
 - 3. Fresh water shall be circulated from the bottom of the hole to clear the well of drilling mud and cuttings after the well is drilled.
 - 4. Loading of anodes and other equipment in the well shall be done in the presence of the ENGINEER. At minimum, 48-hour notice shall be given by the CONTRACTOR to the ENGINEER prior to loading anodes. Loading of the anodes into the well shall begin early enough in the day to ensure completion of all loading, including backfilling, during regular working hours.
 - 5. The well shall be covered with a steel trench plate or other heavy device that blocks access and cannot be removed by hand whenever the well is left unattended.
- C. Well Casing
 - 1. The CONTRACTOR may elect to install the well with or without a casing. In the event that the well collapses for any reason, including the elimination of the casing, the well shall be relocated, re-drilled, and the original hole abandoned at the CONTRACTOR's expense. Only a metallic casing may be used in the coke breeze column.
- D. Vent Pipe
 - 1. The bottom of the vent pipe shall be securely capped with a PVC cap solvent-welded to the vent pipe.

2. The vent pipe shall be installed along with the first anode placed in the hole by attaching it to one of the centralizer straps with a stainless steel clamp. The vent pipe shall not be attached to the anode itself. Obtain the ENGINEER's acceptance of the attachment before the vent pipe is lowered into the hole. Sections of vent pipe shall be joined to one another as the first anode, with the vent pipe attached, is lowered into the hole. Joints shall be solvent-welded.
3. The top of the vent pipe shall be temporarily sealed during the coke breeze loading process. Any foreign material entering the vent pipe shall be removed.

E. Anodes

1. Loading of anodes and other equipment in the well shall be done in the presence of the ENGINEER. A minimum of 48 hours' notice shall be given prior to loading anodes. Loading of the anodes into the well shall begin early enough in the day to ensure completion of all loading, including backfilling, during regular working hours. Loading shall not be commenced later than 1:00 p.m. unless the CONTRACTOR has obtained prior written acceptance from the ENGINEER.
2. The ENGINEER shall visually inspect the insulation on the anode lead wire for abrasion or other damage to the insulation and wire before and as the anode is lowered into place. Anodes with damaged insulation or wire are not acceptable and shall not be installed. Splices are not allowed on the anode wire.
3. Attach the centering devices to the anodes before lowering them in the well. All sharp edges on the centering device assembly shall be taped with vinyl electrical tape to preclude damaging any wires while lowering anodes into place.
4. The terminal end of the anode wires shall be identified with permanent wire markers.
5. Anode No. 1 shall be lowered into the well supported by the attached lead wire. The CONTRACTOR shall fabricate an apparatus that allows the anodes to be lowered by the lead wire, but does not bend the wire into a radius less than 2.5 inches. The vent pipe shall be secured to the centering device on Anode No. 1, not the anode itself, and lowered alongside Anode No. 1. A soil resistance meter, furnished and operated by the ENGINEER, shall be connected between the anode lead wire for Anode No. 1 and the pipeline drain wire. The drain wire should be installed and be accessible to the ENGINEER during the time of testing. The CONTRACTOR shall stop lowering the anode at 10-foot intervals to tape the anode lead wire to the vent pipe and to allow the ENGINEER to measure the resistance profile of the anode well. This shall continue to the bottom of the hole and the vent pipe shall be secured in place.
6. Continuing with Anode No. 2, the anodes shall be lowered into the well by the attached lead wires. The vent pipe shall not be attached to the centralizers or lead wires for Anodes No. 2 and all subsequent anodes. The ENGINEER may adjust the depths of the individual anodes to avoid high resistance soil layers. When an anode has been placed at the final depth, it shall be securely fixed in that position prior to coke breeze backfill.
7. Anodes shall not be backfilled until the ENGINEER has inspected the placement of the anodes and given permission to backfill.

F. Coke Breeze Backfill

1. Coke breeze shall be placed using a slurry pump that pumps the coke into the bottom of the hole using a tremie pipe, allowing the hole to be filled from the bottom up. Coke breeze shall not be pumped through the vent pipe.
2. Coke breeze shall be mixed with water when introduced into the hole to prevent bridging or the creation of voids. Minimize the risk of bridging by ensuring the hole has sufficient water and the backfilling rate is controlled. In the event that voids or bridging does occur, the CONTRACTOR shall correct the deficiency to the satisfaction of the ENGINEER.
3. Coke breeze shall be placed in the hole at a steady rate to ensure the coke breeze does not bridge or block the hole. The hole shall be kept completely full of water during placement of backfill.
4. Backfill settling and anode coverage will be determined by measuring the anode-to-earth resistance from the digital resistance meter. During coke breeze backfilling, the ENGINEER will measure the resistance between the lowermost uncovered anode and the pipeline drain wire. Coverage of the anode will be indicated by a rapid decrease in resistance, normally by at least 50%. As soon as coverage of a lower anode is indicated, the circuit shall be attached to the next highest anode in the hole. Testing will continue until coverage of all anodes has been verified. The ENGINEER shall record the resistance of each backfilled anode. At least 20 feet of coke breeze shall be added above the top anode. The CONTRACTOR shall sound the anode hole with a weighted tape measure and determine the final height of the coke breeze column.
5. Coke shall be allowed 24 hours to settle. After 24 hours, the coke column shall be topped off, as required, to achieve the specified coke column length.
6. Incomplete coverage of each anode with coke breeze shall be cause for rejection of the anode well.
7. The CONTRACTOR shall record the total weight of coke breeze placed in each anode well.

G. Well Seal

1. Backfilling operations above the coke breeze column shall begin no sooner than 24 hours after installation of the coke breeze to allow for settling. Backfilling shall be done continuously and without interruption until the hole is sealed.
2. Collapse of the hole prior to the introduction of the seal material shall be cause for abandonment of the well at the CONTRACTOR's expense.
3. Sealing materials shall not be allowed to drop from the top of the hole. All materials shall be pumped into the hole from the top of the coke breeze column to the top of the hole.
4. If well casing materials are used in the construction of the well, then the annular space between the well bore and the casing shall also be sealed with a conductive grout.
5. Sealing material shall not enter the vent pipe.

6. The CONTRACTOR shall record the volume of sealing material installed in the hole.

H. Well Head

1. The well head shall be a concrete traffic box set at the top of the anode hole and shall contain slack for the anode lead wires, as indicated on the Drawings.
2. The concrete traffic box lid shall be cast iron and marked "ANODE."

I. Storage and Disposal of Drilling Fluids, Cuttings, and Mud

1. During the drilling and loading process, drilling fluids, cuttings, and mud shall be stored onsite in uncontaminated, watertight, lockable debris boxes. Alternative storage methods may be used only with prior approval of the ENGINEER.
2. Drilling mud and cuttings shall be disposed of by the CONTRACTOR at a suitable disposal site.

- J. For lateral conduit runs, install wires in PVC conduit set at the center of trench. Maintain sufficient slack in wire to prevent wire from being unduly stressed or broken during backfill operations.

3.5 SURFACE GROUND BED FOR GALVANIC ANODES

- A. Prepackaged anodes shall be installed at the locations indicated on the Drawings.
- B. Plastic or paper wrapping shall be removed from the anode prior to lowering the anode into the hole. Anodes shall not be suspended by the lead wires. Damage to the canvas bag, anode-to-wire connection, copper wire, or wire insulation before or during installation will require replacement of the entire anode assembly. Anodes shall be inspected and approved prior to backfilling.
- C. Anodes shall be backfilled with native soil. Backfilling with native soil shall proceed in 6-inch lifts, compacting the soil around the anode during each lift, until the backfill has reached grade. Upon completion of compaction of backfill to the top of the anode, and prior to filling the hole and compacting the backfill to the surface, a minimum of 10 gallons of fresh water shall be poured into the hole to saturate the prepackaged anode backfill and surrounding soil.
- D. Anode lead wires shall be routed and terminated on the panel board as shown in the Drawings.

3.6 TEST STATIONS

- A. Test stations shall be installed at the approximate locations shown on the Drawings. The CONTRACTOR shall field verify all final locations, subject to acceptance by the ENGINEER. Test stations shall be located within the pipeline easement. Test stations shall be located in areas not subject to vehicular traffic, such as sidewalks, unless otherwise approved by the ENGINEER.
- B. For flush-mounted test stations, place the bottom of the test box on native soil. Do not place rock, gravel, sand, or debris in the box. Install 4,000 psi concrete collar with reinforcement after placement of the test box to finished grade. Provide sufficient sloping in the concrete pad or surrounding pavement to provide drainage away from the test box.

- C. Connect wires to the terminal board as shown on the Drawings. Each wire shall be identified with a permanent wire identifier within 4 inches of the termination. After installation, all wire connections in the test station shall be tested by the Contractor to ensure they meet the requirements herein.
- D. For foreign pipeline test stations, the CONTRACTOR shall notify the owner of foreign utility piping for which foreign pipeline crossing test stations are to be installed. Notification shall be provided at least 2 weeks in advance. Test leads to foreign pipelines shall be installed in the presence and to the satisfaction of a representative of the foreign pipeline owner.
- E. The CONTRACTOR shall provide global positioning system (GPS) coordinates for each test station location with a minimum accuracy of 1 meter or 3 feet. The CONTRACTOR shall submit the GPS coordinates of the test stations to the ENGINEER after installation.

3.7 WIRES

- A. Buried wires shall be laid straight without kinks. Each wire run shall be continuous in length and free of joints or splices, unless otherwise indicated. Care shall be taken during installation to avoid punctures, cuts, or other damage to the wire insulation. Damage to insulation shall require replacement of the entire length of wire at the CONTRACTOR's expense.
- B. At least 12 inches of slack (coiled) shall be left for each wire at each flush-to-grade test station. Wire slack shall be sufficient to allow removal of wire extension for testing.
- C. Wire shall not be bent into a radius of less than eight times the overall wire diameter.
- D. The wire conduits must be of sufficient diameter to accommodate the wires. This shall be determined by the number and size of wires in accordance with the applicable codes and standards.
- E. Conduit shall be installed to a minimum depth of 30 inches below grade.
- F. Install caution tape above buried wire and conduits at a maximum depth of 24 inches below grade. Every 3 feet, double over the tape for a distance of 8 inches to increase the apparent flexibility of the tape.

3.8 WIRE IDENTIFICATION TAGS

- A. All wires shall be coded with wire identification tags within 4 inches of the wire end indicating diameter and type of pipe.
- B. Wire identification tags shall be placed on all wires prior to backfill and installation of test stations.

3.9 EXOTHERMIC WELD CONNECTIONS

- A. Exothermic weld connections shall be installed in the manner and at the locations indicated. Exothermic welds shall be spaced at least 6 inches apart from other exothermic welds, fittings, and circumferential welds.

- B. Coating materials shall be removed from the surface over an area of sufficient size to make the connection and as indicated on the Drawings. The surface shall be cleaned to bare metal per SSPC SP11 prior to welding the conductor. The use of resin impregnated grinding wheels will not be allowed.
- C. Only enough insulation shall be removed such that the copper conductor can be placed in the welding mold. If the wire conductor diameter is not the same as the opening in the mold, then a copper adapter sleeve shall be fitted over the conductor.
- D. The CONTRACTOR shall be responsible for testing all test lead and bond wire welds. The ENGINEER, at his or her discretion, shall witness these tests. After the weld has cooled, all slag shall be removed and the metallurgical bond shall be tested for adherence by the CONTRACTOR. A 22-ounce hammer shall be used for adherence testing by striking a blow to the weld. Care shall be taken to avoid hitting the wires. All defective welds shall be removed and replaced in a new location at least 6 inches away from the original weld location.
- E. All exposed surfaces of the copper and steel shall be covered with insulating materials.
 - 1. For dielectrically coated pipes, a plastic weld cap with integrated primer shall cover the exothermic weld and surrounding area. All surfaces must be clean, dry, and free of oil, dirt, loose particles, and all other foreign materials prior to application of the weld cap.
 - 2. For mortar coated pipes, epoxy putty covered with mortar shall be applied over the exothermic weld and surrounding area. The mortar shall match the exterior mortar on the pipe.
- F. The CONTRACTOR shall inspect both the interior and exterior of the pipe to confirm that all coatings and linings removed or damaged as a result of the welding have been repaired. The CONTRACTOR shall furnish all materials, clean surfaces, and repair protective coatings and linings damaged as a result of the welding. Repair of any coating or lining damaged during welding shall be performed in accordance with coating or lining manufacturer's recommendations.
- G. After backfilling pipe, all test lead pairs shall be tested for broken welds using a standard ohmmeter. The resistance shall not exceed 150% of the theoretical wire resistance, as determined from published wire data.

3.10 JOINT BONDS

- A. Joint bonding shall be provided across flexible couplings and all non-welded joints to ensure electrical continuity, except where insulating joints have been installed to provide electrical isolation. Joint bonds shall be of the type, size, length, and number shown on the Drawings and installed as indicated.
- B. Bonding wires shall allow at least 2 inches of movement in the pipe joint. The wire shall be attached by exothermic welding. At least 2 bond wires shall be provided between all discontinuous joints.

- C. For ductile iron pipe, the CONTRACTOR may, at his or her own expense, provide weld plates that are installed by the pipe manufacturer at the spigot end of the pipe. Provision of the weld plates does not relieve the CONTRACTOR from responsibility for repair of damage to the coating or lining as a result of exothermic welding of the pipe. Coating repairs shall be performed in accordance with coating manufacturer's recommendations.

3.11 DIELECTRIC INSULATING FLANGE KITS

- A. All insulating components of the insulating flanged gasket set shall be cleaned of dirt, grease, oil, and other foreign materials immediately prior to assembly. If moisture, soil, or other foreign matter contacts any portion of these surfaces, disassemble the entire joint and clean with a suitable solvent. Dry the entire joint. Once completely dry, reassemble the joint.
- B. Care shall be taken to prevent any excessive bending or flexing of the gasket. Creased or damaged gaskets shall be rejected and removed from the job site.
- C. Bolt holes in mating flanges shall be properly aligned at the time bolts and insulating sleeves are inserted to prevent damage to the insulation. Follow the manufacturer's recommended bolt tightening sequence. Center the bolt insulating sleeves within the insulation washers so that the insulating sleeve is not compressed and damaged.
- D. After flanged bolts have been tightened, each insulating washer shall be inspected for cracks or other damage. All damaged washers shall be replaced.
- E. When the flange is determined to be properly functioning to the full satisfaction of the OWNER, approval will be granted to proceed with installation. Do not proceed with coating, lining, or backfilling the insulating joint prior to gaining approval to proceed. If the coating or lining is applied prior to gaining approval to proceed, the coating or lining shall be completely removed to the satisfaction of the OWNER at the CONTRACTOR's expense. If the insulating joint is backfilled prior to gaining approval from the OWNER, the CONTRACTOR shall completely excavate the insulating joint at the CONTRACTOR's expense.
- F. After testing and acceptance by the OWNER, coat the interior insulating flange a minimum of two pipe diameters beyond the gasket with high-solids epoxy to a 10 mil (minimum) dry film thickness. Follow the manufacturer's surface preparation and application procedures.
- G. After testing and acceptance by the OWNER, coat the exterior insulating flange and a minimum of two pipe diameters beyond the gasket with the wax tape system specified herein.

3.12 MONOLITHIC INSULATING JOINTS

- A. Install monolithic insulating joints in accordance with the manufacturer's instructions. Do not attempt to disassemble the joint at any time.
- B. Before installation, inspect bore for foreign particles and clean if necessary. When lifting and moving the monolithic insulating joint, support with strapping on both sides of the hub. Do not lift the monolithic insulating joint by the ends.

- C. Install by butt-welding each end of the factory assembled joint to attaching pipe or fitting. When welding, equipment shall be grounded on the side of the joint being welded.
- D. Do not remove original coating with solvent or abrasion. This may damage the insulating gaskets or create a residue that is conductive.

3.13 PETROLATUM WAX TAPE

- A. Petrolatum wax tape systems shall be applied on insulating joints and non-cathodically protected metallic appurtenances and fittings, regardless of whether they are bare or factory coated, as indicated in the Drawings. Extend the petrolatum wax tape coating system over any adjacent pipe coating by a minimum of two pipe diameters. Petrolatum wax tape systems shall be applied in accordance with NACE RP0375, AWWA C217, these Specifications, and the Manufacturer's recommendations.
- B. Surfaces shall be cleaned of all dirt, grease, oil and other foreign materials immediately prior to coating. Loose rust, loose paint and other foreign matter shall be removed in accordance with SSPC SP2 or SP3.
- C. A prime coating shall be applied in a uniform coating over the entire surface to be wrapped. A liberal coating shall be applied to threads, cavities, shoulders, pits, and other irregularities.
- D. Petrolatum wax tape shall be applied immediately after applying the primer using a 1-inch overlap. A spiral wrap shall be used and slight tension shall be applied to ensure that there are no air pockets or voids. For bolts, nuts, and other irregular shapes, cut strips of wax tape and apply them by gloved hand so that there are no voids or spaces under the tape. Apply a sufficient amount of tape to completely encapsulate all exposed steel surfaces. After applying the tape, the applicator shall firmly press and smooth out all lap seams and crevice areas. The tape shall be in tight intimate contact with all surfaces. The minimum wax tape thickness shall be 70 mils over smooth surfaces and 140 mils over sharp and irregular surfaces, or more as required to fill all voids.
- E. Apply two layers of outer covering over the wax tape coating by tightly wrapping it around the pipe such that it adheres and conforms to the wax tape. Secure the outer covering to the pipe with adhesive tape.

3.14 ANODE HEADER WIRE-TO-ANODE LEAD WIRE SPLICES

- A. Secure the copper split bolt or copper crimp onto the wires to provide electrical continuity between the wires. Apply two half-lapped layers of rubber splicing tape to the split bolt or crimp forming a smooth, water-tight seal over the split bolt and exposed copper. The rubber splicing tape shall extend 2 inches over the wire's insulation. Cover the rubber tape with two layers of half-lapped PVC electrical tape.

3.15 REFERENCE CELLS

- A. Reference electrodes shall be installed as shown on the Drawings.
- B. Reference electrode lead wire shall be terminated on the panel board as shown on the Drawings.

3.16 WIRE CONNECTIONS

- A. After installation, all wire connections shall be tested to ensure electrical continuity at the test station locations by the CONTRACTOR to ensure that they meet the requirements and intent of the Contract Documents.

3.17 RESTORATION SERVICES

- A. Compaction of backfill for anodes and trenches shall match the existing conditions and shall be in conformance with Excavation and Backfill for Utilities Section (02317).
- B. RESTORATION OF SOD: Restore unpaved surfaces disturbed during the installation of anodes and wires to their original elevation and condition and shall be in conformance with Sodding Section 02922. Preserve sod and topsoil carefully and replace after the backfilling is completed. Replace sod that is damaged using sod of quality equal to that removed. Where the surface is disturbed in a newly seeded area, re-seed the area with the same quality and formula of seed as that used in the original seeding.
- C. RESTORATION OF PAVEMENT: Patch pavement, sidewalks, curbs, and gutters where existing surfaces are removed for construction in conformance with the Pavement Repair and Restoration Section (02951) and Concrete Sidewalks Section (02775).

3.18 ISOLATION TESTING ON INSULATING JOINTS

- A. Insulating joints shall be installed to effectively isolate metallic piping from foreign metallic structures. The CONTRACTOR shall test the performance of these insulating joints before and after backfill.
- B. Before backfill, the CONTRACTOR shall test the insulating joint using a Gas Electronics Model No. 601 Insulation Checker or an approved equivalent. If the testing results indicate less than 100% insulation, then the insulating joints shall be repaired and retested at the CONTRACTOR's expense.
- C. After backfill, testing shall be performed by measurement of native pipe-to-soil potentials at both sides of the insulating joint. If the difference in native pipe-to-soil potentials on both sides of the insulating joint is within ± 100 mV, then additional testing shall be performed, as follows. Temporary CP current shall be circulated on one side of the insulating joint. "On" and "Instant Off" pipe-to-soil potentials shall be measured on the other side of the insulating joint. If the "Instant Off" potential is more negative than the native potential, the insulating joint shall be considered deficient and shall be repaired and retested at the CONTRACTOR's expense.

3.19 ISOLATION TESTING ON CASING INSULATORS

- A. Casing insulators shall be installed as indicated in the Drawings to effectively isolate the pipeline from the casing. The CONTRACTOR shall test the performance of the casing insulators before and after backfill.

- B. Before backfill, the CONTRACTOR shall test the integrity of the insulators by using a Gas Electronics Model No. 601 Insulation Checker or an approved equivalent. If the testing results indicate less than 100% insulation, then the casing insulators shall be repaired and retested at the CONTRACTOR's expense.
- C. After backfill, testing shall be performed by measurement of native pipe-to-soil potentials on the pipeline and the casing at both ends of the casing. If the difference in native pipe-to-soil potentials is greater than 100 mV, then the casing shall be considered isolated from the pipeline. If the difference in native pipe-to-soil potentials between pipe and casing is less than 100 mV, then additional testing shall be performed, as follows. Temporary CP current shall be applied to the pipeline. "On" and "Instant Off" pipe-to-soil potentials shall be measured on the pipeline and the casing at both ends of the casing. If the "Instant Off" potential of the casing is more negative than the native potential of the casing, then the pipe is not isolated from the casing and shall be repaired and retested at the CONTRACTOR's expense.

3.20 CONTINUITY TESTING

- A. Continuity testing of joint bonds shall be performed by the CONTRACTOR's qualified corrosion technician as defined in this section after backfill. The electrical continuity test may additionally be performed before backfill at the CONTRACTOR's option.
- B. The pipe shall be tested for electrical continuity. Continuity shall be verified using the linear resistance method. The pipe should be tested in spans that are no less than 250 feet, unless the pipe is shorter than 250 feet, and no more than 1,000 feet, if test station locations are available. Each test span shall have two test leads connected to the pipe at each end. Existing test stations can be used. A direct current shall be applied through the pipe using two of four test leads. The potential across the test span shall be measured using the other two test leads. The current applied and voltage drop shall be recorded for a minimum of three different current levels.
- C. The theoretical resistance of the pipe shall be calculated. It shall take into account the pipe wall thickness, material, and joint bonds.
- D. The average measured resistance shall be compared to the theoretical resistance of the pipe and bond wires. If the measured resistance is greater than 125% of the theoretical resistance, then the joint bonds shall be considered deficient and shall be repaired and retested at the CONTRACTOR's expense. If the measured resistance is less than 90% of the theoretical resistance, then the test and/or calculated theoretical resistance shall be considered deficient and the test span shall be retested and/or recalculated at the CONTRACTOR's expense. If the piping forms a loop which allows current to flow both in and out of the test span, then consideration shall be made for current circulating through both the loop and the test span.
- E. Alternative continuity testing methods can be submitted to the ENGINEER for consideration and approval.

3.21 FINAL SYSTEM CHECKOUT

- A. Upon completion of the installation, the CONTRACTOR shall provide testing of the completed system by a Corrosion Technician, and the data shall be reviewed by a Corrosion Engineer hired by the Contractor to ensure conformance with the Contract Documents, NACE SP0169, and NACE SP0286.
- B. The testing described herein shall be in addition to and not substitution for any required testing of individual items at the manufacturer's plant and during installation.
- C. Testing shall be performed at all test leads of all test stations, junction boxes, and locations of exposed pipe as soon as possible after installation of the CP system.
- D. Testing shall include the following and shall be conducted in accordance with NACE TM0497:
 - 1. Measure and record native pipe-to-soil, casing-to-soil, and anode-to-soil potentials at all test locations. CONTRACTOR shall submit data to ENGINEER a minimum of 48 hours before energizing the cathodic protection system.
 - 2. Verify electrical isolation at all insulating joints and casing insulators per NACE SP0286. CONTRACTOR shall submit data to ENGINEER a minimum of 48 hours before energizing the cathodic protection system.
 - 3. Confirm electrical continuity of the cathodically protected pipeline or structure in accordance with this Section. CONTRACTOR shall submit data to ENGINEER a minimum of 48 hours before energizing the cathodic protection system.
 - 4. Measure and record the "On" and "Instant Off" structure-to-soil or structure-to-water potentials at each location after the structure has been given adequate time to polarize.
 - 5. Measure and record the current output of each anode when the CP system is initially turned on and again after it has been given adequate time to polarize.
- E. Test results shall be analyzed to determine compliance with NACE SP0169.
- F. Test results shall be analyzed to determine if stray current interference is present. Stray current interference is defined as a ± 50 mV shift in a pipeline's pipe-to-soil potential that is caused by a foreign current source. Stray current interference shall be tested on the project pipeline and foreign pipelines that have a reasonable chance of being affected by stray currents.
- G. The CONTRACTOR shall provide a written report, prepared by the Corrosion Engineer, documenting the results of the testing and recommending corrective work, as required to comply with the Contract Documents. Any deficiencies of systems tested shall be repaired and re-tested by the CONTRACTOR at no additional cost to the OWNER.

**** END OF SECTION ****

Section 15180

VALVE ACTUATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section covers furnishing manual and powered valve actuators and accessories as specified herein.

1.2 MEASUREMENT AND PAYMENT

- A. No separate payment. Payment for valve actuators shall be included in the unit price of associated valve.

1.3 REFERENCES

- A. ANSI/AWWA C504 – Rubber Seated Butterfly Valves
- B. ANSI/AWWA C507 – Ball Valves, 6 In. Through 60 In.(150 mm Through 1,500 mm)
- C. ANSI/AWWA C516 – Large-Diameter Rubber-Seated Butterfly Valves, Sizes 78 In. (2,000 mm) and Larger
- D. ANSI/AWWA C542 – Electric Motor Actuators for Valves and Slide Gates

1.4 SUBMITTALS

- A. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.
- B. Submittal drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.
- C. For networked valve actuators, information on the available input and output assemblies shall be submitted for the protocol(s) specified to be provided. The submittal shall identify the version of the selected network protocol for which the device has been tested and certified.
- D. For electric actuators, certified copies of reports covering proof-of-design testing of the actuators as set forth in Section 5 of ANSI/AWWA C542, together with an affidavit of

compliance as indicated in Section 6.3 of ANSI/AWWA C542, shall be submitted to Engineer before the actuators are shipped.

E. Operation and Maintenance Manuals:

1. Operating and maintenance manuals shall be prepared by personnel familiar with the operation and maintenance specific information for the specific purpose of educating operating and maintenance personnel unfamiliar with such equipment.
2. Equipment number and identification from the Drawings shall be used.
3. Manual shall be provided in accordance with Section 01782 – Operation and Maintenance Data.
4. Manual shall contain the following minimum contents:
 - a. Installation instructions, including instructions for unpacking, installing, aligning, checking, and testing. Foundation data, allowable piping loads, and electrical design shall be included.
 - b. Procedures for long-term storage, including startup procedures after long-term storage.
 - c. Operating instructions to provide pre-operational checks, start up and shut down, and description of all control modes, including emergency procedures for all fault conditions and actions to be taken for all alarms.
 - d. Maintenance instructions shall include preventive, corrective, and troubleshooting. Schedules for maintenance are to be included. Provide a list of tools required to service the equipment.
 - e. Electrical control system schematic diagrams with operation description and part identification.

F. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the Contract Documents. Submittals are for review of general conformance with the design concepts of the project and general compliance with the Contract Documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Minimum of five years (5) of experience producing substantially similar equipment and able to show evidence of at least five (5) installations in satisfactory operation for at least five (5) years in the continental United States.
- B. Component Supply and Compatibility: Obtain all equipment included in this Section, regardless of the component manufacturer, from a single equipment manufacturer to ensure compatibility and proper operation.
- C. Shop Tests:
 1. The electric actuator shall be tested at the actuator manufacturer's shop and the valve manufacturer's shop. Actuator testing at the valve manufacturer's shop is to be performed with the actuator mounted to the valve that will be installed for this project. Performance tests shall be certified by the actuator manufacturer for compliance in accordance with AWWA C542 performance tests. If the actuator test results do not fall within the manufacturer's recommended bounds, the actuator shall be repaired and retested.
- D. The following tests shall be performed at the actuator manufacturer's shop to ensure actuator operation:
 1. Voltage, phase, and frequency at rated horsepower and RPM.
 2. Stroke time or output speed.
 3. Seating (or maximum dynamic) torque.
 4. Position switch accuracy.
 5. Torque switch and limit switch function and calibration.
 6. Motor current measured under maximum advertised torque and at advertised horsepower and RPM.
- E. The valve manufacturer shall be responsible for calibrating the limit and position switches and mechanical stops in the valve manufacturer's shop. The valve manufacturer shall perform the following tests at the valve manufacturer's shop with the actuator mounted on the valve that will be installed for this project:
 1. A manufacturer's representative shall check the installation and mounting of the actuator on the valve as part of the testing procedure. If the actuator is incorrectly installed or mounted the actuator shall be reinstalled and inspected.
 2. Operate the valve five (5) times throughout its full range of operation with motor current measurements taken at each five (5) percent of opening interval. The motor amperage shall not exceed actuator manufacturer's recommended maximum running torque or seating torque when the valve is running or seating respectively.
 3. A hydrostatic test shall take place to demonstrate position switch accuracy. An actuator indicating a position of 0 percent open shall correlate to a completely closed valve and shall be verified with a hydrostatic test. If the valve fails the hydrostatic test, the actuator will be repositioned to ensure full closure and the test repeated.

- F. Testing to be witnessed by Engineer in accordance with valve Sections.
- G. Actuators shall not be shipped prior to the Engineer approving factory testing and certification. Factory certification shall include valve manufacturer's verification of limit and position switch functions.

1.6 MANUFACTURER SERVICES

- A. The services of a factory-trained service engineer, specifically trained on the type and size of the specified equipment, shall be provided. Qualifications of the service engineer, in the form of a project-based resume, shall be submitted for approval. The listed man-day requirements are exclusive of travel time, and shall not limit or relieve the Contractor of the obligation to provide sufficient service necessary to place the equipment into fully satisfactory and functioning condition.

1.7 WARRANTY

- A. In addition to the Contractor's General Warranty and Guarantee, the actuator manufacturer shall provide a three (3) year warranty that shall include both parts and service.
- B. In the event of failure of any part or parts of the equipment during the warranty period, provided that the equipment has been operated and maintained in accordance with good practice, the Supplier shall furnish, deliver, and install the defective part or parts at the Supplier's expense. The Supplier shall warranty that service will be provided within one (1) business day following the request for service. The Authority shall be named as holder of the warranty.
- C. All actuators provided as part of this Section shall be guaranteed to operate for the design conditions described herein without defects in materials, workmanship, or operational failure for the warranty period.
- D. The warranty period shall be interpreted as the 36-month period following the installation, adjusting, and acceptance testing, and the start of actual operation of the equipment, or 42 months following delivery of the equipment, whichever comes first.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

- B. Actuators shall be furnished and installed by the valve manufacturer in their shop prior to shipping for installation on the job site. It shall be the actuator manufacturer's responsibility to coordinate torque output and cycle time with the valve manufacturer.
- C. Actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, as specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.
 - 1. Power Supply: Power supply to electric actuators will be as indicated on the Drawings.
 - 2. Marking: Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.
 - 3. Temporary Number Plates: Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve by number or service as indicated on the Drawings or in the valve schedule.
- D. The valve manufacturer shall be responsible for actuator sizing and mechanical integration with actuator design. This shall include all mounting brackets and yokes required to mate the actuator with the valve. The Contractor shall be responsible for coordinating the arrangement of the actuator on valves to accommodate installation in the space shown on the Drawings. In some cases, the actuator installation arrangement has been shown on the Drawings. However, final verification of the actuator arrangement prior to the submission of shop drawings and release for fabrication after approval shall be the Contractor's responsibility.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. General
 - 1. Actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective valve sections.
 - 2. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.
- B. Valve Actuators
 - 1. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential

across the valve and maximum velocities through the valve where indicated in the respective valve schedules.

2. Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings or directed by Engineer.
3. When valves are to be buried, submerged, or installed in vaults; the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective valve schedules but not less than 20 feet.

C. Limit Switches

1. Limit switches shall be provided as indicated on the Drawings or in the valve schedules.
2. For manual actuators, each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts AC and 5 amperes at 125 volts DC. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".
3. Limit switches for standard electric actuators shall be as indicated in this Section.

2.3 MATERIALS

- A. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of the applicable referenced standard(s).
- B. All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of operating mechanism shall be supported by roller bearings or needle bearings.

2.4 MANUAL ACTUATORS

A. General

1. Manual actuators shall be provided by the valve manufacturer of the types listed in the valve specifications or schedules.
2. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

3. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall conform to the valve specification. Unless specified otherwise, direct-bury valves and valves in subsurface vaults shall open clockwise. Above- ground and plant valves shall open counterclockwise. Each valve body or actuator shall have cast thereon the word "OPEN" and an arrow indicating the direction to open.
 4. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.
 5. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.
 6. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.
 7. Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the handwheel or chainwheel or an input of 300 foot-lbs on the operating nut.
- B. Handwheels
1. Handwheel diameters shall be at least 8 inches but not more than 24 inches for 30 inch and smaller valves and not more than 30 inches for 36 inch and larger valves.
- C. Chainwheels
1. Unless otherwise specified in the valve schedules, all valves with center lines more than 7'-6" above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized or zinc plated carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.
- D. Wrench Nuts

1. Unless otherwise specified in the valve schedules or on the Drawings, wrench nuts shall be provided on all buried valves and on all valves that are to be operated through floor boxes. Unless otherwise directed by Engineer, all wrench nuts shall comply with Section 4.4.13 of ANSI/AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

E. Operating Stands

1. Operating stands shall be provided in the locations indicated on the Drawings or as indicated in the valve and gate schedules. Operating stands shall support the handwheel or crank approximately 36 inches above the floor. Handwheel and crank-operated actuators shall be suitable for operation with a portable actuator for a 2 inch wrench nut. A suitable adapter coupling shall be furnished with each actuator to couple the portable actuator to the actuator pinion shaft as required.
2. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem.

F. Wall Brackets

1. Wall brackets shall be provided to support manual actuators in the locations indicated on the Drawings or in the respective valve schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2.5 STANDARD ELECTRIC ACTUATORS

A. Actuators sized for valve operation shall be designed with the following safety factors:

1. Gear box output torques shall be 1.5 times the maximum required bare stem torque for the valve using maximum upstream pressure and 0 psig on the downstream side.
2. Motor shall supply two (2) times the required torque into the gear box.
3. Rated maximum input torque for gear boxes shall be sufficient to accommodate maximum electric motor actuator output. If a secondary gear box is required, it shall be designed to withstand the locked rotor torque of the actuator.
4. Gear box shall also be sized so that maximum required output torque of electric motor actuator does not exceed 75% of the maximum input torque into the gear box.

5. Closing and Opening Time: Actuators shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or longer as indicated in the valve schedules. Minimum normal closure time shall be based on a geared reducer, not jogging the motor. The electric motor actuator controls shall allow for jogging the motor at a programmable reduced closing speed during the final 15 degrees minimum of closing.
- B. Actuators will operate on one of the following process-control signals described below. Refer to the SCADA System Architecture Drawing, Loop Drawing, PLC I/O List, Modulating Valve Schematic, and Division 13 specifications for more information.
1. Capabilities shall be provided to position the valve locally with a Local/Off/Remote selector switch and Open/Stop/Close momentary contact push buttons. The Local/Off/Remote selector switch shall provide status contacts for when in 'Remote'.
 2. For modulating service and when in remote operating mode, the actuator shall accept a 4-20mA DC position control signal, and shall position the valve 0-90 degrees of travel in proportion to the control signal.
 3. Contact closure limit switches for valve fully open and fully closed.
 4. Valve position indicator. The valve actuator shall have a local digital or mechanical indicator integral with the operator with a 0-100 percent scale and shall be clearly visible through a transparent window.
 5. Remote feedback signal. A position transmitter shall be provided with easily accessible zero and span adjustment potentiometers. The remote position indicator shall include an absolute encoder signal in percentage open and a current converter to provide a 4-20mA DC position proportional signal and Modbus register when required on the Drawings. The transmitter shall be capable of driving an external load of 0 to 400 ohms. Accuracy of the transmitted signal shall be ± 2 percent of span. Repeatability and hysteresis shall be within 1 percent.
 6. All terminals for 4-20 ma and contact closure for control or status of the valve shall be for testing only. Normal control and monitoring of the valves shall be via Modbus TCP/IP signals.
- C. Actuators shall include multi-turn units for rotary applications utilizing bevel, spur and worm gear drives, requiring 100 to 20,000 ft-lbs of torque at the nut; or 10,000 to 500,000-lbs of thrust at the nut in a multi-turn direct-drive configuration.
- D. Gears: The actuator gear housing shall be constructed of cast aluminum. The gears shall be the double reduction type and have an alloy bronze worm gear and heat-treated carbon steel spur gear. The electrical compartment enclosure shall be constructed of O-ring sealed cast aluminum with a polyester or polyethylene epoxy coating. All hardware for the gearbox and electrical enclosure shall be Type 316 stainless steel. Enclosure shall be submersible to IP68 (7m for 72hrs), and NEMA 6 compliant.

- E. Motor: The motor shall be a squirrel-cage induction type with a nominal duty of not less than 15 minutes. Jogging motors shall not be allowed. Motor shall have Class F insulation, with a minimum of two Class B rise thermal contacts embedded within the windings for thermal protection. Motor shall be powered by 60-Hz, three phase (3), 230 or 460 volt power as shown on the drawings.
- F. Limit Switch: The actuator shall be capable of stopping by use of limit switches or limit sensors. Limit switches shall be the gear-driven, cam operated, snap-action type. The contact rating shall be 600V. The current rating shall be 6A resistive at 120V and 3A resistive at 240V. Limit sensors shall be contact-less Hall effect sensors with a maximum angular resolution of 7.5 degrees at the output shaft.
- G. Torque Switch: The actuator shall be furnished with torque limiting switches or a torque sensor. The contact rating for torque switches shall be 600V. The current rating shall be 5A resistive at 120V. There shall be one SPDT contact each for the OPEN and CLOSE directions. The torque switches shall be dedicated to torque protection. Torque shall be measured at worm and wheel gear assembly and transmitted to the control module. Torque sensor shall be independently configurable in the range of 40-100 percent of rated torque in 1 percent increments.
- H. Actuators shall be used for modulating service. The actuator shall operate (position) on contact closure for throttling operation (standard).
- I. Handwheel: Actuator shall be furnished with side mounted handwheel or crank handle for manual operation of the valve. A declutching mechanism shall be integral to the drive allowing the use of the manual override to position the valve when powered and/or during a power outage. The declutching lever shall be lockable in the motor position. Electric operation shall return device to auto mode.
- J. The actuator operating range shall be -20 to 150 degrees F.
- K. Electric Actuator Closure Times: Electric actuators shall be capable of providing the minimum valve closure times noted in the table below:

MINIMUM VALVE ELECTRIC ACTUATOR CLOSURE TIMES			
Valve Size	Location	Minimum Normal Closure Time (sec)	Reduced closing speed final 15 degrees of closing (%).
96	Northeast Meter	480	50%
96	BFV #1 Little York Rd.	480	50%
96	BFV #2 Shady Ln.	480	50%
96	BFV #3 Ella Blvd	480	50%

84	BFV #5 Cunningham Rd.	480	50%
84	BFV #6 Highway 6	480	5

L. Manufacturers:

1. Electric actuators for open-close or modulating service shall be multi-turn type and shall be EIM (Bettis) "M2CP", Limitorque "L120", or Rotork "CK Range" without exception.
2. Each standard electric actuator shall be furnished complete with a motor, gearing, handwheel, limit switches and torque sensors, lubricants, heating elements, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a cast iron or aluminum alloy housing.

M. Controllers:

1. Reversing controllers shall be both mechanically and electrically interlocked and shall be provided with the necessary direct-operated auxiliary contacts for required interlocking and control.
2. Space heating elements shall be provided to prevent condensation in the motor and limit switch housing. Heaters shall be continuously energized.
3. Terminal facilities for connection to power leads, switches, position transmitter, and digital signals shall be provided in a readily accessible terminal compartment large enough to allow easy routing and termination of conductors. Each terminal compartment shall have at least two openings for external electrical conduits.
4. A fused control power transformer and any required DC power supplies shall be located within the IP 68 actuator enclosure.
5. Provide integral control panel with lockable three-position Local-Off-Remote selector, Open, Close, Stop pushbutton and high intensity LED indication for Power On, Open, Close, and Over torque.
6. Provide lockable cover plate or enclosure to prevent tampering or unauthorized access of any local push button or selector switch.
7. Provide for digital control and communication configurable for Ethernet Modbus TCP/IP and furnish any required device installer software.
8. The contractor shall provide a single laptop computer with color screen with software from the valve manufacturer for testing the valve remotely by sending Modbus TCP/IP commands. Reference Field Testing requirements below."

2.6 ACTUATOR ACCESSORIES

A. Extension Stems

1. Extension stems and stem guides shall be furnished when indicated in the valve schedule or on the Drawings, or otherwise required for proper valve operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the actuator shaft. Extension stems shall be connected to the actuator or torque tube with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.
2. At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, grease lubricated and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet, whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.
3. Extension stems for buried valve actuators shall extend to within 6 inches of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.
4. Extension stems for buried valve actuators shall be provided with position indicators as specified in this Section, other valve specification sections, or valve schedule.

B. Position Indicators

1. Unless otherwise specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.
2. For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.
3. Each actuator for butterfly valves, except where located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.

C. Floor Boxes

1. Openings through concrete slabs provided for key operation of valves shall be provided with a cast iron floor box complete with cover. The floor box shall be of the depth indicated on the Drawings. Where the operating nut is in the slab, the

stem shall have a guide to maintain the nut in the center of the box; where the nut is below the slab, the opening in the bottom of the box shall accommodate the operating key.

2. Each floor box and cover shall be shop coated with manufacturer's standard coating.

D. Torque Tubes

1. Torque tube shall utilize pipe rather than solid shafting between the valve input shaft and the output shaft of the floor stand operator. Torque tube shall be installed plumb. A vertical adjustment of 2 inches shall be provided in the torque tube installation. Torque tube shall be coated with the same material as the submerged valve.

E. Operating Stand

2. Operating stands shall be provided in the locations indicated on the Drawings or as indicated in the valve schedules. Operating stands shall support the motor actuator with the handwheel or crank approximately 36 inches above the floor, top of concrete or platform. Handwheel or crank- shall be suitable for operation with a portable actuator for a 2-inch AWWA wrench nut. A suitable adapter coupling shall be furnished with each actuator to couple the portable actuator to the actuator pinion shaft as required.
3. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem

2.7 SHOP PAINTING

- A. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.
- B. The following surfaces shall be painted with the indicated product:

SURFACE

PAINT PRODUCT

Polished or Machined Surfaces

Rust-preventive compound.

Other Surfaces

Epoxy.

Actuators and Accessories

Universal primer.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Actuators will be installed on the valves in accordance with valve manufacturer's and actuator manufacturer's requirements and recommendations.

3.2 NETWORK SETUP

- A. A manufacturer's representative for the electric actuator manufacturer shall inspect all network terminations for conformity with the manufacturer's recommended methods of terminating the network to each actuator, and shall notify the Contractor of any wiring modifications required. The manufacturer's representative shall configure the Ethernet actuator communication module, set network addresses for each valve and prove communication over the network. The valve manufacturer shall furnish the register map and any required information to the control system supplier that will allow the specified control and monitoring for each electric actuator.

The Contractor shall coordinate activities between the manufacturer's representative and the control system integrator that may be working directly for the Authority or at any lower tier subcontract under one or more general contractors working for the Authority.

3.3 FIELD TESTS AND INSPECTIONS

- A. The Engineer shall be given two (2) weeks notice prior to field testing actuators. Any material, equipment, instruments, and personnel required for the tests shall be provided by the Contractor. Testing shall be conducted in the presence of the Engineer and certified field test reports shall be submitted by the Contractor. Testing shall be done under the direction of the approved factory-trained service.
- B. A field functional test shall be performed to ensure actuator operation. Operate the valve five (5) times throughout its full range of operation with motor current measurements taken at each five (5) percent of opening interval. The motor amperage shall remain within the values defined by the motor manufacturer.
- C. The testing shall include remotely testing all valve PLC I/O listed in Specification 13402 via Modbus TCP/IP commands. The contractor shall provide a laptop and software to connect remotely using the supplied spare cellular modem. The purpose of the test is to simulate the valve operation from the future Central or Repump Station over the cellular modems.
- D. If the installed equipment does not meet the requirements of this Section during any of the field testing, then corrective action shall be taken by the Supplier or Contractor, and the actuators shall be retested to ensure full compliance with the specified requirements. All costs associated with required corrective action shall be at no additional cost to the Authority.

END OF SECTION

Section 15440

SUBMERSIBLE NON-CLOG SUMP PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section covers furnishing labor, materials, equipment and incidentals necessary to install sump pumps and accessories as specified herein.

1.2 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for this item. Payment for sump pumps shall be included in the unit price of associated valve vault.

1.3 REFERENCES

- A. ASTM A 48 - Standard Specifications for Gray Iron Castings
- B. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
- C. ASTM F 593 - Stainless Steel Bolts, Hex Cap Screws, and Studs
- D. ANSI/UL 778 - Standard for Motor-Operated Water Pumps
- E. ANSI/UL 508A - Standard for Industrial Control Panels
- F. ANSI/NFPA 70 - National Electrical Code Article 409 Industrial Control Panels

1.4 SUBMITTALS

- A. Complete drawings, details, cut-sheets and specifications covering the pump, motor, seals, slide rail, controls and appurtenances shall be submitted in accordance with the Submittal Procedures section.
- B. Submittal drawings shall include wiring diagrams for the electrical control equipment.
- C. Operation and Maintenance Manuals:
 - 1. Manual shall be provided in accordance with Section 01782 – Operation and Maintenance Data and contain the following minimum contents.
 - a. Installation instructions, including instructions for unpacking, installing, aligning, checking, and testing. Foundation data, allowable piping loads, and electrical design shall be included.

- b. Procedures for long-term storage, including startup procedures after long-term storage.
- c. Operating instructions to provide pre-operational checks, start up and shut down, and description of all control modes, including emergency procedures for all fault conditions and actions to be taken for all alarms.
- d. Maintenance instructions shall include preventive, corrective, and troubleshooting. Schedules for maintenance are to be included. Provide a list of tools required to service the equipment.
- e. Electrical control system schematic diagrams with operation description and part identification.

1.5 QUALITY ASSURANCE

A. Qualifications:

- 1. Manufacturer: Xylem Gould (Model 3888D3), or approve equal by
 - a. Flowserve
 - b. KSB
 - c. Ebara
 - d. Barnes
 - e. Hydromatic

PART 2 PRODUCTS

3.1 GENERAL REQUIREMENTS

- A. Pump case: Cast iron, ASTM A48, Class 30.
- B. Motor housing: Cast iron, ASTM A48, Class 25.
- C. Impeller: Cast iron, ASTM A48, Class 30.
- D. Discharge elbow: Gray cast iron, ASTM A48, class 30.
- E. Shaft: Stainless steel, ANSI, Series 300 or 400.
- F. Wear rings: Not required
- G. O-rings: Nitrile (Buna-N) or fluorocarbon (Viton).
- H. Fasteners: Stainless steel.
- I. Lower ring seal: Silicone-carbide both faces.
- J. Upper ring seal: Silicone-carbide both faces.
- K. Seal metal parts: Stainless steel.

3.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Discharge Size: 3 inches
- B. Connection: Flanged
- C. Rated HP: 2
- D. Rated Speed: 1750 rpm
- E. Design flow: 185 gpm
- F. Design TDH: 30 ft
- G. Minimum shutoff head: 43 ft
- H. Minimum run-out capacity: 320 gpm
- I. Service: Unscreened storm water
- J. No. of floats for pump control: 3
- K. Remote telemetry contacts: High Level Alarm.

3.3 SHAFT SEALS

- A. Seal shaft with double mechanical seal, or two independent, tandem mounted seals running in an oil-filled chamber.
- B. Hold interface in contact by its own spring system.

3.4 MOTORS

- A. Provide pump with FM or UL listed motor designed for area classification shown on Drawings.
- B. Provide motor of totally submersible design, constructed with epoxy or polyseal encapsulated windings, air-filled or dielectric oil filled, with Class F insulation and rated for continuous duty operation.
- C. Motor shall be 3 PH, 60 cycle, 230 V.
- D. Assure motor is capable of running dry for extended periods without damage to motor or seal.

3.5 POWER AND CONTROL CABLES

- A. Provide power cable and control cable to pump suitable for submersible applications.
- B. Severe duty rated, oil and water resistant.
- C. Epoxy seal on motor cable entry
- D. Provide single length power cable and control cable.

- E. Provide each cable with a strain relief, cord grip.
- F. Provide normally open non-mercury micro-switch float switches for pump down duty and high level alarm.

3.6 GUIDE RAIL

- A. Provide cast iron sliding guide bracket fastened to pump flange which properly aligns the pump discharge with a cast iron base elbow for watertight seal without rotation. Guide the entire weight of the pumping unit by guide rails. The guide rails shall not support any portion of the weight of the pump.
- B. Fasteners and supports: Stainless steel.
- C. Guide rails: Schedule 40 stainless steel.

3.7 CONTROLS

- A. Provide a complete control system enclosed in NEMA 4X stainless steel watertight enclosure with continuous seam weld and continuous hinge with neoprene gasket in cover.
- B. Exterior door of control panel shall have a dead front and lockable hasp. Inner door inside the enclosure mounted on a continuous vertical steel hinge and secured with quarter turn captive latch.
- C. No panel top penetrations shall be allowed.
- D. Include short-circuit and ground fault protective device with NEMA style operating disconnect means on the inner door capable of being locked in the open position. Provisions for locking shall remain in place with or without the lock installed.
- E. Provide an equipment grounding lug and bond to the enclosure.
- F. Provide combination motor circuit protector or breaker type controller for motor overload and short circuit protection with a three-phase ambient compensated overload relay.
- G. Provide control power transformer for control circuit of 24 VAC.
- H. Mount selector switch, reset and indicating devices on the inner door inside the panel enclosure.
- I. Hand-Off-Auto selector switch.
- J. Amber power ON LED push-to-test pilot light.
- K. Green pump running LED push-to-test pilot light.
- L. Independent high-level alarm float switch, time delay relay, side mounted flashing alarm beacon and auxiliary contact.
- M. Lead level float switch power ON time delay relay in Auto.

- N. Low level float switch power OFF control relay and in Auto.
- O. Overload reset button to reset overload relays.
- P. Surge protection device, Line to Line and Line to Ground, 50kA per phase Max.
- Q. Condensation heater.
- R. Auxiliary contacts, control and motor leads wired to terminal blocks.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Pumping equipment shall be installed in accordance with the manufacturer's recommendations, the details shown on the drawings and as specifies herein.
- B. Guide rails shall be plumb and secured at the top to supports anchored to the structure.
- C. Ensure the sump is free from strings, nails debris and trash before installing the pump on the slide rail.
- D. Pump shall be connected to a properly grounded equipment ground lug. Wiring and grounding shall be installed to comply with ANSI/NFPA 70.

3.2 FIELD TESTS AND INSPECTIONS

- E. The Engineer shall be given notice prior to field testing. Any material, equipment, instrument, or personnel required for the tests shall be provided by the Contractor. Testing shall be conducted in the presence of the Engineer and certified field test reports shall be submitted by the Contractor. Testing shall be done under the direction of the approved factory-trained service.
- F. A field functional test shall be performed to ensure hand and automatic operation. Operate the pump through five (5) cycles with motor current measurements taken at each cycle. The motor amperage shall remain within the values defined by the motor manufacturer.
- G. Factory representative shall inspect the installation of power and control cords, and confirm the wiring is correct for automatic and hand operation.
- H. If the installed equipment does not meet the requirements of this Section during any of the field testing, then corrective action shall be taken by the Supplier or Contractor, and the pump shall be retested to ensure full compliance with the specified requirements. All costs associated with required corrective action shall be at no additional cost to the Authority.

END OF SECTION

Section 15600

SPECIALTY VALVES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Specialty pressure reducing/sustaining and flow control valves.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices:

- 1. Measurement for valves is on unit price basis for installation of each valve type and size.
- 2. Payment includes piping and appurtenances necessary for complete installation of valve.
- 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract; payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASME B 16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
- B. ASTM A 48 - Standard Specification for Gray Iron Castings.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit formally certified flow graphs over the entire range of flow for each valve size and type.
- C. Submit manufacturer's certification that valves meet applicable requirements of this Specification Section.

1.05 QUALITY CONTROL

- A. Submit manufacturer's warranty against defects in materials and workmanship for one year from date of Substantial Completion.

PART 2 P R O D U C T S

2.01 FLOW CONTROL VALVE

- A. The full port flow control valve shall be a Cla-Val Model 343-01BCSYKC combination electronic actuated rate of flow and solenoid shutoff valve with X105LCW single limit switch assembly of the size indicated. Include the associated orifice plate assembly with all associated piping and fittings.

2.02 PRESSURE SUSTAINING/REDUCING VALVE

- B. The full port pressure sustaining/reducing valve shall be a Cla-Val Model 92-59BSYKC combination pressure reducing, pressure sustaining valve with low flow bypass and X105L2W dual limit switch assembly of the size indicated.

2.03 BALL VALVE

- A. Ball valve for sampling line at air valve assemblies shall be stainless steel (ASTM A351, Type CF8M) for body and ball, full port, and one or two piece configuration.
- B. Ball valve shall have threaded connections.
- C. Ball valve shall be manufactured by Nibo, Valtorc, or approved equal.

PART 3 E X E C U T I O N

3.01 METER FITTING HOOKUP

- A. Support valve piping, level and plumb, during installation. Support valves with concrete at a minimum of two locations.
- B. Provide full-face 1/8-inch black neoprene or red rubber gasket material on flanged joints. Provide bolts and nuts made from approved corrosion-resistant material.
- C. Tighten bolts in proper sequence and to correct torque.
- D. Visually check for leaks under normal operating pressure following installation. Repair or replace leaking components.

END OF SECTION

Section 16709

COMMUNICATIONS CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Communications conduit with inner ducts.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. This item will be measured by the linear foot of "Communications Conduit" installed. Each linear foot shall include: conduit (HDPE and Rigid Steel), inner microduct, tracer wire, pull tape, and all incidentals. Conduit shall be measured horizontally along the surface from center of communications service box to center of communications service box or other terminating point. Risers shall be measured as the amount of conduit extending from the ground surface.
 - 2. Payment for the work performed and materials furnished in accordance with this item will be paid for at the unit price bid for "Communications Conduit." The price shall be full compensation for furnishing and installing conduit; for trenching, boring, excavating, furnishing and placing backfill, replacing pavement structure, sod, riprap, curbs or other surfaces; for marking location of conduit (when required); for furnishing and installing all fittings, junction boxes, special radius sweeps, and expansion joints, conduit straps; and for all labor, tools, equipment and incidentals necessary to complete the work.

PART 2 PRODUCTS

2.1 MATERIALS

Provide new materials that comply with the details shown on the plans and the requirements of this specification.

- A. High Density Polyethylene (HDPE) Outer Conduit

Conduit for fiber optic cable shall be Schedule 80 HDPE, having a 2 inch internal diameter. The outer HDPE conduit provides a shell of high tensile and compression strength. The outer conduit is orange in color. Conduit shall terminate without bends if possible. Bends shall have a minimum unsupported radius of 48 inches. 90 degree bends are prohibited.

HDPE conduit shall be joined by solvent-weld method in accordance with the conduit manufacturer's recommendation. No reducer couplings shall be used unless specifically indicated on the drawings.

B. Inner Microduct

All HDPE Conduit shall be installed with a 3-way Microduct, including an outer Orange HDPE 0.070 in sheath, and three (3) 12.7mm OD, 10mm ID Microducts, and #20 Copper tracer wire. Colors for Microducts shall be Blue, Brown, and Orange. The Microduct shall have ribs on the inside to facilitate pulling/blowing future fiber optic cable into the Microduct. Each Microduct has a designated purpose and shall be provided in each of the following colors:

Blue – Function TBD
Brown – Function TBD
Orange– Function TBD

Reference COH standard:
Blue (City traffic operations)
yellow (public safety)
red (City IT)
green (other)

A minimum of 6 inches of the Microduct shall extend beyond the end of the outer conduit

C. Manufacturers

1. Outer HDPE 2" Sch 80 Smoothwall – Duraline
2. Microduct – Duraline Futurepath
3. Or Approved Equal

PART 3 EXECUTION

3.1 CONSTRUCTION METHODS

A. General

Place conduit in accordance with the details shown on the plans or as directed. Conduit shall be buried 48 inches deep underground unless otherwise shown on the plans.

Many areas along the pipeline are considered sensitive and require the outer conduit to be installed at the same time as the pipeline (i.e. one pass installation). In these

sensitive areas, as marked on the drawings, the Contractor shall install the outer conduit as the pipeline trench is being backfilled. All soil must be compacted prior to laying the conduit. Reference Division 02 Specifications for Compaction and Backfill requirements. The Contractor shall not plow long distances (i.e. multiple previously open cut sections) and install the outer conduit after the pipeline construction is complete.

Areas designated as non-sensitive, as shown on the Drawings, may be plowed or trenched to install the outer conduit after the pipeline has been installed and backfilled (i.e. two pass installation).

Splicing of the outer conduit is allowed as required between new trench sections along the pipeline. Splicing of the Microduct is only allowed at ends of reels, or as approved by the Engineer.

Prior to installation of Microduct duct, pull or blow a mandrel to ensure that it is free from obstruction. Reference Testing section below.

All bends in conduit shall use as long a radius as possible to facilitate installation of the fiber optic cable in the future. Conduit bends shall have a minimum radius of 48 inches.

Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas. Immediately repair any damaged infrastructure including sidewalks, driveways, to equivalent conditions prior to construction.

Any obstructions to the trenching / boring operation such as utilities, structures, sprinkler systems, etc. are to be protected from damage by the contractor during construction and until the work is completed. In the event of damage, the contractor shall be responsible for the repair / replacement at his expense with materials and methods which leave the damaged items in as good or better condition than original. Immediately after installation of conduit, backfill pits, excavation or trenches.

B. Boring / Directional Drilling

Boring shall be performed at road and utility crossings as indicated on the Drawings. The boring method used shall be approved by the Engineer prior to commencing work.

Excavate suitable pits for conducting boring operations (clearly mark/protect excavation to avoid injury by public). Pits shall be kept 2 feet clear outside of the pavement edge. Install conduit so there is no interference with street operation or no structure is weakened or damaged.

C. Tracer Wire

One (1) No. 20 AWG Green tracer wire shall be supplied with the Microduct to use in locating the conduit. One end shall be connected to the ground rod in each communication service box, as shown on the Drawings. The other end of the tracer wire shall be left unconnected.

D. Sealing

At each stage of installation of the outer conduit and Microduct, the ends shall be sealed / plugged to prevent entrance of dirt, water and gases. Temporary plugging of conduit is required between successive trench sections to prevent entry of dirt and water. Reference ETCO Fast-Loc Plug model RPL-1930 or similar product.

E. Testing

1. General

Testing shall be performed on the outer duct, Microduct, and tracer wire before and after installation, as outlined below. The Contractor shall record all associated test data, including:

- a. Test type
- b. Conduit type, and Microduct color (if applicable)
- c. Conduit installation location
- d. Reel number (pre-installation only)
- e. Test Pressures at start and end
- f. Mandrel or BB size
- g. Test Voltage (if applicable)
- h. Test Results

Any test failure shall result in replacement of associated conduit sections or tracer wire. Examples of test failure include:

Failure to hold pressure test on Microduct

Failure to pass mandrel or BB through entire outer duct or Microduct

Failure of pressure continuity on Microduct

Failure of tracer wire resistance

All Test Reports shall be submitted for review by the Engineer, and as part of the

O&M manual.

2. Outer Duct Testing

After installation of the 2" outer duct, and prior to installation of the Microduct, the Contractor shall perform the following tests:

- a. Sponge Test – Blow sponge approximately 2 times the pipe inner diameter down the duct to remove any grit or water.
- b. Mandrel Test – Blow mandrel 70 – 80 % of duct inner diameter via compressed air. If the mandrel comes out from the other end, then the duct has no blockage and it is considered Passed and ready for Microduct installation. If the mandrel does not come from the other end, then the duct is either kinked or blocked. To identify the blockage or kinked location, a transmitter is passed through the duct which will get stuck behind the mandrel and then the blockage point in the duct is tracked with the help of receiver. The blocked portion of the duct shall be dug out and replaced.

3. Microduct Testing

The Contractor shall perform the following tests. The tracer wire shall be tested while the Microduct is still on the reel. The other tests shall be performed after installation in the ground, inside the outer duct.

- a. Tracer Wire Resistance Test – While still on the reel, the tracer wire shall be tested end to end for resistance with a multimeter. The resistance in Ohms shall be logged. An open circuit shall be considered a failed test.
- b. Continuity Test – Air shall be blown down each of the three tubes, one at a time. The exit tube will be confirmed to be the same color as the pressurized tube.
- c. Pressure Test - Perform a static pressure test upon each individual Microduct,

Which can be performed by capping one end of the Microduct and installing a valve upon the other end. Pressurize the Microduct to between 95 PSI and 140 PSI. Place a pressure gauge on the cap and monitor the pressure for five (5) minutes. The pressure should remain stable. If there is more than a 5% loss in pressure, all connections should be checked for integrity and the test repeated. Once the test is repeated and if the pressure continues to fall, the test will be considered a failure, and the duct must be replaced.

- d. Sponge Test – Blow sponge approximately 2 times the diameter down the duct to remove any grit or water.

- e. BB Test – Blow a plastic BB 60-80 % of duct inner diameter (i.e. 6mm - 8mm) via compressed air. If the BB comes out from the other end, then the duct has no blockage and it is considered Passed. Failure to pass the BB through the duct constitutes failure of the test. If the BB does not come from the other end, then the duct is either kinked or blocked. The entire length of Microduct shall be pulled out and replaced. Any replaced duct shall undergo repeated testing until it passes all tests. Note that the planned cable diameter is 5.4mm, so the minimum BB size shall be 6mm. Reference Dura-line Technical Bulletin - Futurepath and Microduct Test Procedures for additional setup and testing information. Reference McMaster-Carr # 9614K24 and 9614K57 for test BB (6.35 mm and 7.94mm respectively).
- f. After completion of all tests, the outer duct shall be plugged to prevent liquids and gas from entering.

END OF SECTION

Section 16737

COMMUNICATION SERVICE BOX

PART 1 GENERAL SECTION INCLUDES

A. Standard, off-street buried communication service boxes with lids and aprons to be utilized for support of communications cable installations.

B. MEASUREMENT AND PAYMENT

Unit Prices.

1. Payment for this item will be measured by each "Communication Service Box" installed.
2. Payment for the work performed and materials furnished in accordance with this item will be paid for at the unit price bid for "Communication Service Box" of the type and size specified. This price is full compensation for excavating and backfilling; constructing, furnishing, and installing the communication service boxes and concrete aprons when required; and equipment, labor, materials, tools, and incidentals necessary to complete the work.

PART 2 PRODUCTS

A. General Requirements.

1. Ensure the communication service box is capable of supporting burial in off-street areas where occasional, non-deliberate heavy vehicle loads may be experienced.
2. Sustaining light vehicle loads in applications such as parking lots or driveways, and does not deteriorate when buried in various types of soils with varying moisture content.

B. Functional Requirements.

Ensure that the communication service box is capable of the following applications:

1. Ensure box withstands 600 lb. per square foot applied over the entire sidewall with less than 1/4 -inch deflection per foot length of box.
2. Ensure box or extension is footed with a minimum of 1-1/4-inch flange.

3. Ensure box and cover withstand a test loading of 20,000 lb. over a 10-inch by 10-inch area centered on the cover with less than 1/2-inch deflection. Meet Western Underground Standards 3.6. Supply certification by an independent laboratory or factory testing documentation witnessed and certified by a professional engineer licensed in the State of Texas.
4. Manufacture box and cover from polymer concrete reinforced with two layers of continuous strands of woven or stitched borosilicate fiberglass cloth. Construct the polymer concrete from catalyzed polyester resin, sand, and aggregate. Ensure a minimum compressive strength of 11,000 psi. Polymer concrete containing chopped fiberglass or fiberglass reinforced plastic is not acceptable.
5. Pulling of fiber optic cable interconnected with conduit.
6. Provide cable racks for storage of 100 feet of fiber optic cable within minimum bend radius limits of 10 inches (250mm).
7. Provide access to cable and equipment after installation to support maintenance.
8. Accommodate a degree of security of cable and equipment from vandalism and theft by requiring an access tool.
9. Provide modular additions of conduits through punchouts or other means from four sides.
10. Provide protection of cable and devices from run-over by light vehicles and non-deliberate heavy vehicles without damage to the communication service box or enclosed cables and devices.
11. Support National Electrical Code requirements for grounding of shielded metallic strength cables as deemed necessary by the communications installation design.
12. Support water drainage of any invasive water.

C. Specifications.

Communication service box material will comply with the following standards:

1. ANSI/SCTE 77 2013, Specification for Underground Enclosure Integrity
2. ANSI/UL 746A, Polymeric Materials – Short Term Property Evaluations

D. Environmental Requirements.

1. Galvanic Corrosion. Ensure communication service box material does not contain dissimilar metals which support galvanic corrosion nor any chemicals which, when in contact with non-corrosive metals used in the splice enclosure construction would cause metal deterioration.

E. Manufacturer(s):

1. Communication Service Box - Martin Enterprises 2436 / 30PC
2. Cable Racks – Inwesco 10XXX
3. Cable Hooks – Inwesco 10XXX
4. Or Approved Equal

PART 3 CONSTRUCTION

A. Install communication service boxes in accordance with the following requirements:

Requirements. Construct for in-ground installation ensuring a flush fitting with sidewalks and grass areas, using light weight, high strength materials.

1. Lid Requirements. Ensure lid is exposed to the environment and in public view.
 - a. Include locking devices which are non-corrosive and require removal using a special access tool/key.
 - b. Include provisions for lifting and removal using a maintenance tool.
 - c. Lids shall be secured with tamper resistant standard Penta-Head Stainless Steel bolts.
 - d. Traffic-bearing.
 - e. Blend into the environment, providing an acceptable appearance.
 - f. Perform its intended function without failure for a minimum of 20 years of exposure to the environment as defined in this specification.
 2. General Requirements. Communications service box dimensions will be per plan drawings.
- B. Drainage. Construct communication service box without a bottom, allowing drainage via a bottom trench fill of 10 inches of crushed rock (concrete or limestone), and 2 inches of pea gravel on top.
- C. Concrete Apron. Provide a concrete apron (typically 10” wide x 6” to 8” deep) surrounding the ground box. The apron shall include #3 reinforcing steel.

PART 4 SAFETY REQUIREMENTS.

A. Human Safety.

1. Ensure communication service box is free from chemicals that are harmful to

humans and is not constructed with sharp edges.

2. Lid will have a minimum coefficient of friction of 0.5. The lid will not be constructed to cause slippage of a person walking across the covered communication service box during wet conditions.
 3. Lid installation and removal tools will comply with normally recognized industry safety standards.
- B. System Safety. Communication service box material will contain no chemicals that may damage normal communications wire line, optical cable, splice enclosures or other equipment normally used in outdoor communications network installation. Also, communication service box will not reflect any light.

END OF SECTION