



CONTRACT DOCUMENTS
AND TECHNICAL SPECIFICATIONS
FOR CONSTRUCTION OF
60-INCH AND 54-INCH WATERLINE ALONG
GRANT ROAD AND COPELAND ROAD
PROJECT NO. 28-B

HARRIS COUNTY, TEXAS



Carl D. McConnell
5/18/2020

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INVITATION TO BID

Date: May 29, 2020

**North Harris County Regional Water Authority
3648 Cypress Creek Pkwy, Suite 110
Houston, Texas 77068**

PROJECT TITLE: Proposed 60" and 54" Water Line Along Grant Road and Copeland Road

PROJECT NO.: 28B CONTRACT NO.: 1

LOCATION: Grant and Copeland Road, Houston, Texas, Harris County

Sealed BIDs in duplicate will be received at the office of the North Harris County Regional Water Authority, 3648 Cypress Creek Pkwy, Suite 110, Houston, Texas 77068 until 10:00 a.m. local time, Tuesday, June 23, 2020, then publicly opened and read. BIDs received after the closing time will be returned unopened. Due to the COVID-19 pandemic and the State and Federal guidelines of not gathering in groups of more than ten (10) people, members of the public who wish to attend the Bid Opening for this project must do so by telephone. To attend the Bid Opening by telephone, dial (877) 286-5733 and enter conference ID: 275 356 489#.

General Contractors are invited to attend a virtual pre-bid conference for this project. The pre-bid conference will be held on Tuesday, June 9, 2020, at 10:00 a.m. local time. To participate by video conference, go to <https://tinyurl.com/NHCRWA-Project-28B>. To participate by telephone conference only dial (877) 286-5733 and enter conference ID: 733 293 630#.

Bid Security in the amount not less than five percent (5%) of the total amount of the BID must accompany each BID as a guarantee that the Successful Bidder will enter into a proper Contract and execute Bonds and Guaranties on the forms provided within eight (8) days after the date Contract Documents are received by the CONTRACTOR. Bid Security shall be in accordance with Section 00100 - Instructions to Bidders and Section 00700, Paragraph 5.1.1 of the General Conditions.

Copies of the Bidding Documents may be obtained from www.civcastusa.com; search NHCRWA Project 28B. Bidders must register on this website in order to view and/or download specifications and plans for this project. There is NO charge to view or download documents. Bidders may submit questions online through CIVCAST at www.civcastusa.com.

This contract is contingent upon release of funds from the Texas Water Development Board. Any contract or contracts awarded under this Invitation for Bids is/are expected to be funded in part by a loan or grant from the Texas Water Development Board. Neither the state of Texas, nor any of its departments, agencies, or employees are or will be a party to this Invitation for Bids or any resulting contract.

The OWNER reserves the right to reject any or all BIDs and to waive technical defects in bidding.

Jimmie Schindewolf, P.E.
General Manager,
North Harris County
Regional Water Authority

INSTRUCTIONS TO BIDDERS

1. Defined Terms

Terms used in these Instructions to Bidders are defined in Section 00700 - General Conditions of the Construction Contract.

2. Copies of Bidding Documents

2.1. Complete sets of the Bidding Documents, in the number and for the payment sum stated in the Invitation to Bid, may be obtained from www.civcastusa.com.

2.2. Complete sets of Bidding Documents must be used in preparing BIDs; neither OWNER, PROJECT MANAGER, nor ENGINEER assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents or otherwise associated with the Bidding Documents.

2.3. OWNER, PROJECT MANAGER, and ENGINEER, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining BIDs for the Work and do not confer a license or grant for any other use. BIDDER may not make copies of the Bidding Documents. Ownership of the Bidding Documents shall remain with the OWNER.

3. Qualifications of BIDDERS

To demonstrate qualifications to perform the Work, each BIDDER must submit, with their BID in a separate sealed envelope, detailed written evidence such as financial data, previous experience, present commitments, and proof that the BIDDER has the personnel, equipment, and material to execute the work required by the Contract Documents or any other such data as may be called for below. Although OWNER will not ordinarily release financial data submitted to it under this paragraph, BIDDERS should expect that this information may be available for public scrutiny if it is submitted.

4. Examination of Contract Documents and Site

4.1. It is the responsibility of each BIDDER, before submitting a BID:

4.1.1. to examine thoroughly the Contract Documents and other related data identified in the Bidding Documents (including “technical data” referred to below);

4.1.2. to visit the site to become familiar with and satisfy BIDDER as to the general, local, and site conditions that may affect cost, progress, performance, or furnishing of the Work;

4.1.3. to consider federal, state, and local Laws and Regulations that may affect cost, progress, performance, or furnishing of the Work;

4.1.4. to study and carefully correlate BIDDER’s knowledge and observations with the Contract Documents and such other related data; and

4.1.5. to promptly notify PROJECT MANAGER of all conflicts, errors, ambiguities or

discrepancies which BIDDER has discovered in or between the Contract Documents and such other related documents.

4.2. Reference is made to the General and Supplementary Conditions for identification of those reports of explorations and tests of subsurface conditions at or contiguous to the site which have been utilized by ENGINEER in preparation of the Contract Documents. BIDDER may rely upon the general accuracy of the “technical data” contained in such reports but not upon other data, interpretations, opinions, or information contained in such reports or otherwise relating to the subsurface conditions at the site, nor upon the completeness thereof for the purposes of bidding or construction. **OWNER, PROJECT MANAGER, AND ENGINEER EXPRESSLY DISCLAIM ANY AND ALL WARRANTIES THAT THE INFORMATION, DATA, INTERPRETATIONS, AND OPINIONS SHOWN, INDICATED, OR CONTAINED IN THE REPORTS ARE ACCURATE, CORRECT, COMPLETE, OR FIT FOR THEIR INTENDED PURPOSES.**

Copies of such reports will be made available by OWNER to any BIDDER on request. Those reports and drawings are not part of the Contract Documents, but the “technical data” contained therein upon which BIDDER is entitled to rely as provided in Paragraph 4.2 of the General Conditions has been identified and established in Paragraph SC-4.2 of the Supplementary Conditions. BIDDER is responsible for any interpretation or conclusion drawn from any “technical data” or any such data, interpretations, opinions, or information.

4.3. Information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to OWNER, PROJECT MANAGER, and ENGINEER by owners of such Underground Facilities or others, and OWNER, PROJECT MANAGER, and ENGINEER do not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary Conditions. **OWNER, PROJECT MANAGER, AND ENGINEER EXPRESSLY DISCLAIM ANY AND ALL WARRANTIES THAT THE INFORMATION, DATA, INTERPRETATIONS, AND OPINIONS SHOWN, INDICATED, OR CONTAINED IN THE PLANS ARE ACCURATE, CORRECT, COMPLETE, OR FIT FOR THEIR INTENDED PURPOSES.** It is to be anticipated by the CONTRACTOR that some of the Underground Facilities located at or contiguous to the site will be found at locations that may differ from the sites shown on the Contract Documents. It is part of the scope of CONTRACTOR’s work to perform the exploratory work necessary to precisely identify the exact locations of Underground Facilities. It is also to be anticipated that these may be underground Facilities at or contiguous to the site that have not been identified in the Contract Documents and it is part of the scope of the work to be able to accommodate the likelihood of encountering some additional underground Facilities.

4.4. Provisions concerning responsibilities for the adequacy of data furnished to prospective BIDDERS with respect to subsurface conditions, other physical conditions and Underground Facilities, and possible changes in the Contract Documents due to differing or unanticipated conditions appear in Paragraphs 4.2 and 4.3 of the General Conditions.

4.5. Before submitting a BID, each BIDDER will be responsible to obtain such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning

conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise, which may affect cost, progress, performance, or furnishing of the Work, or which relate to any aspect of the means, methods, techniques, sequences, or procedures of construction to be employed by BIDDER and safety precautions and programs incident thereto or which BIDDER deems necessary to determine its BID for performing and furnishing the Work in accordance with the time, price, and other terms and conditions of the Contract Documents.

4.6. On request, OWNER will provide each BIDDER access to the site to conduct such examinations, investigations, explorations, tests, and studies as each BIDDER deems necessary for submission of a BID. BIDDER must fill all holes and clean up and restore the site to its former condition upon completion of such explorations, investigations, tests, and studies.

4.7. The submission of a BID will constitute an incontrovertible representation by BIDDER that BIDDER has complied with every requirement of this Article 4, that, without exception, the BID is premised upon performing and furnishing the Work required by the Contract Documents, and applying the specific means, methods, techniques, sequences, or procedures of construction (if any) that may be shown or indicated or expressly required by the Contract Documents, the BIDDER has given PROJECT MANAGER written notice of all conflicts, errors, ambiguities, and discrepancies that BIDDER has discovered in the Contract Documents, and written resolutions thereof by PROJECT MANAGER are acceptable to BIDDER, that the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work, that the BIDDER has no questions regarding the Work, that the BIDDER has all information necessary to make a fully informed BID, and that the BIDDER has conducted all tests at the site it deems necessary.

4.8. The provisions of 4.1 through 4.7, inclusive of this Article, do not apply to Asbestos, Polychlorinated biphenyls (PCBs), Petroleum, Hazardous Waste, or Radioactive Material covered by Paragraph 4.5 of the General Conditions.

5. Availability of Lands for Work, etc.

The lands upon which the Work is to be performed, rights-of-way and easements for access thereto and other lands designated for use by CONTRACTOR in performing the Work are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by OWNER unless otherwise provided in the Contract Documents.

6. Interpretations and Addenda

6.1. All questions about the meaning or intent of the Bidding Documents are to be directed to PROJECT MANAGER. Interpretations or clarifications considered necessary by PROJECT MANAGER in response to such questions will be issued by Addenda mailed, transmitted by facsimile machine, or delivered to all parties recorded by PROJECT MANAGER as having received the Bidding Documents. Questions received less than ten days prior to the date for opening of Bids may not be answered. Only questions answered by formal written Addenda will

be binding. Oral and other interpretations or clarifications may not be relied upon and will not be binding upon OWNER or PROJECT MANAGER or legally effective.

6.2. Addenda may also be issued to modify the Bidding Documents as deemed advisable by OWNER or ENGINEER.

7. Bid Security

7.1. Each BID must be accompanied by Bid Security made payable to OWNER in an amount of five percent (5%) of BIDDER's maximum Bid price and in the form of a certified or cashier's check or a Bid Bond issued by a surety meeting the requirements of Paragraph 5.1.1 of the General Conditions.

7.2. The Bid Security of Successful Bidder will be retained until such BIDDER has executed the Agreement, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid Security will be returned. If the Successful Bidder fails to execute and deliver the Agreement and furnish the required contract security within eight (8) days after the Notice of Award, OWNER may annul the Notice of Award, and the Bid Security of that BIDDER will be forfeited. The Bid Security of other BIDDERS whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earlier of the seventh day after the Effective Date of the Agreement or the thirty-sixth day after the BID opening, whereupon Bid Security furnished by such BIDDERS will be returned. Bid Security with Bids which are not competitive will be returned within seven (7) days after the BID opening.

8. Contract Times

The Contract Times, as defined in Paragraph 1.13 of the General Conditions, are set forth in the Agreement.

9. Liquidated Damages

Provisions for liquidated damages are set forth in the Agreement.

10. "Or-Equal" Items

The Contract, if awarded, will be on the basis of materials and equipment described in the PLANS or specified in the Specifications without consideration of possible "or-equal" items. Whenever it is indicated in the PLANS or specified in the Specifications that an "or-equal" item of material or equipment may be furnished or used by CONTRACTOR if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submission of any such application by CONTRACTOR to the PROJECT MANAGER for consideration by ENGINEER is set forth in Paragraphs 6.4.1, 6.4.2 and 6.4.3 of the General Conditions and may be supplemented in the Supplementary Conditions.

11. Subcontractors, Suppliers, and Others

11.1. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, and other persons and organizations (including those who are to furnish the principal items of material and equipment) to be submitted to OWNER in advance of a specified date prior to the Effective Date of the Agreement, apparent Successful Bidder, and any other BIDDER so requested, shall, within five (5) days after BID opening, submit to OWNER a list of all such Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, person, or organization if requested by OWNER. OWNER who, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, other person, or organization may, before the Notice of Award is given, request the apparent Successful Bidder to submit an acceptable substitute without an increase in Bid Price.

If the apparent Successful Bidder declines to make any such substitution, OWNER may award the contract to the next lowest BIDDER that proposes to use acceptable Subcontractors, Suppliers, and other persons and organizations. Declining to make requested substitutions will not constitute grounds for sacrificing the Bid Security of any bidder. Any Subcontractor, Supplier, other person, or organization listed and to whom OWNER does not make written objection prior to the giving of the Notice of Award will be deemed acceptable to OWNER subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.5.2 of the General Conditions.

11.2. The apparent Successful Bidder, prior to the Notice of Award, shall identify in writing to OWNER those portions of the Work that such BIDDER proposes to subcontract and after the Notice of Award may only subcontract other portions of the Work with OWNER's written consent.

12. Bid Form

12.1. The Bid Form is included with the Bidding Documents; additional copies may be obtained from the Issuing Office described in the Invitation to Bid.

12.2. All blanks on the Bid Form must be completed by ink.

12.3. BIDs by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary of the corporation. The corporate address and state of incorporation must be shown below the signature.

12.4. BIDs by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature, and the official address of the partnership must be shown below the signature.

12.5. All names must be typed or printed in ink below the signature.

12.6. The BID shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form).

12.7. The street and/or post office box address and telephone and/or fax number for communications regarding the BID must be shown.

12.8. When applicable, evidence of authority to conduct business as an out-of-state corporation in the state where the Work is to be performed shall be provided in accordance with Paragraph 3 above. State contractor license number, if any, must also be shown.

13. Submission of Bids

Each BID shall be submitted at the time and place indicated in the Invitation to Bid and shall be enclosed in a sealed envelope, marked with the Project title and name and address of BIDDER and accompanied by the Bid Security and other required documents. If the BID is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face of it.

14. Modification and Withdrawal of Bids

14.1. BIDs may be modified or withdrawn by an appropriate document duly executed (in the manner that a BID must be executed) and delivered to the place where BIDs are to be submitted at any time prior to the opening of BIDs.

14.2. If, within twenty-four (24) hours after Bids are opened, any BIDDER files a duly signed, written notice with OWNER and promptly thereafter demonstrates to the reasonable satisfaction of OWNER that there were material and substantial mistakes in the preparation of its BID of such a nature as to warrant the withdrawal of a Bid under the common law of the State of Texas, that BIDDER may withdraw its BID and the Bid Security will be returned. Thereafter, that BIDDER will be disqualified from further bidding on the Work to be provided under the Contract Documents.

15. Opening of Bids

BIDs will be opened and read aloud publicly (unless obviously nonresponsive) at the place where BIDs are to be submitted. An abstract of the amounts of the base BIDs and major alternates (if any) will be made available to BIDDERS after the opening of BIDs.

16. Bids to Remain Subject to Acceptance

All BIDs will remain subject to acceptance for sixty (60) days after the day of the BID opening, but OWNER may, in its sole discretion, release any BID and return the Bid Security prior to that date.

17. Award of Contract

17.1. It is the intention of the OWNER to select the lowest responsible responsive BIDDER and make an effort to enter a Contract with that BIDDER. However, OWNER reserves the right

to reject any or all BIDs, including without limitation the right to reject any or all nonconforming, nonresponsive, unbalanced, or conditional BIDs and to reject the BID of any BIDDER if OWNER believes that it would not be in the best interest of the Project to make an award to that BIDDER, whether because the BID is not responsive or the BIDDER is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by OWNER. OWNER also reserves the right to waive all informalities in BIDs and to negotiate contract terms with the Successful Bidder. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum. OWNER also reserves the right to enter a Contract with a BIDDER other than the lowest BIDDER if it does not reach an agreement with the lowest BIDDER.

17.2. In evaluating BIDs, OWNER will consider the qualifications of BIDDERS, whether or not the BIDs comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

17.3. OWNER may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided in the Supplementary Conditions. OWNER also may consider the operating costs, maintenance requirements, performance data, and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

17.4. OWNER may conduct such investigations as OWNER deems necessary to assist in the evaluation of any BID and to establish the responsibility, qualifications and financial ability of BIDDERS, proposed Subcontractors, Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to OWNER's satisfaction within the prescribed time.

17.5. If the contract is to be awarded, it will be awarded to the lowest BIDDER whose evaluation by OWNER indicates to OWNER that the award will be in the best interests of the Project.

17.6. If the contract is to be awarded, OWNER will give Successful Bidder a Notice of Award within sixty (60) days after the day of the BID opening.

17.7. This contract is contingent upon release of funds from the Texas Water Development Board. Any contract or contracts awarded under this Invitation for Bids is/are expected to be funded in part by a loan or grant from the Texas Water Development Board. Neither the state of Texas, nor any of its departments, agencies, or employees are or will be a party to this Invitation for Bids or any resulting contract.

17.8. A governmental entity may not award a governmental contract to a nonresident BIDDER unless the nonresident underbids the lowest BID submitted by a responsible resident BIDDER by an amount that is not less than the amount by which a resident BIDDER would be required to underbid the nonresident BIDDER to obtain a comparable contract in the state in which the

nonresident's principal place of business is located. A non-resident BIDDER is a Contractor whose corporate offices or principal place of business is outside of the state of Texas (Source: Texas Government Code, Chapter 2252, Subchapter A, Nonresident Bidders, §2252.002).

The BIDDER will complete form TWDB-0459, Vendor Compliance with Reciprocity on Non-Resident Bidders, **which must be submitted with the BID.**

18. Contract Security

Paragraph 5.1.1 of the General Conditions and the Supplementary Conditions set forth OWNER's requirements as to performance, payment, and maintenance Bonds. When the Successful Bidder delivers the executed Agreement to OWNER it must be accompanied by the required Bonds.

19. Signing of Agreement

When OWNER gives a Notice of Award to the Successful Bidder, it will be accompanied by the required number (as stated in Section 00500 "Agreement") of unsigned counterparts of the Agreement with all other written Contract Documents attached. Within eight (8) days thereafter, CONTRACTOR shall sign and deliver the required number of counterparts of the Agreement and attached documents to OWNER with the required Bonds. Thereafter, OWNER shall deliver one fully signed counterpart to CONTRACTOR. Each counterpart is to be accompanied by a complete set of the PLANS with appropriate identification.

20. Prebid Conference

A prebid conference will be held as stated in Section 00020 ("Invitation to Bid").

21. Taxes

21.1. CONTRACTOR shall pay all applicable sales, consumer, use, and other similar taxes except as exempted.

21.2. Sales tax. CONTRACTOR shall obtain the necessary documentation so that any sales tax exemptions due to the nature of the Work performed by CONTRACTOR or Subcontractors pursuant to this Agreement shall be applied to this Agreement, and these cost savings due to the Project's exempted status shall be passed on to OWNER. CONTRACTOR and each of its Subcontractors or sub-Subcontractors must obtain a Texas Limited Sales, Excise and Use Tax Permit for all materials required to be purchased in connection with the Project.

22. Retainage

Provisions concerning retainage are set forth in the Agreement.

23. Supplemental Pay Items

Approximate quantity and a minimum unit price have been established for some of SUPPLEMENTAL ITEMS shown in Section 00300-BID. The CONTRACTOR may not bid a unit price less than the minimum value; however, he may increase the minimum unit price. If no entry is made in the spaces provided, the minimum unit prices shown shall apply. These Items are included to facilitate payment for changes and alterations that may be required to complete work. The actual work, as provided by the GENERAL AND SUPPLEMENTARY CONDITIONS OF CONSTRUCTION CONTRACT and TECHNICAL SPECIFICATIONS and shown on PLANS, is described in bid items excluding supplemental pay item. When work covered by SUPPLEMENTAL ITEMS is requested by the CONTRACTOR and approved by OWNER, payment will be based on the quantity actually constructed and unit prices bid in BID.

24. Ownership of Proposals

Submitted Proposals, documentation and supporting materials shall become the property of Owner. Financial data submitted under Paragraph 3 of this Instruction to Bidders will be returned to any unsuccessful BIDDER upon request following Contract award.

25. Division of Project in Unit Prices

The Contract Documents describe a complete Scope of Work to be performed. If the Work is divided for purpose of calculation of compensation into UNIT PRICES for Units of Work, it is to be understood that all aspects of the Work described in the Contract Documents are included in the total Units provided for under the Contract. The fact that the description of Units may not include an itemization of tasks incidental to the Work that are identified in the Contract Documents as parts of the Scope of Work will not relieve CONTRACTOR of the obligation to perform this incidental work for the Unit Prices.

26. HB 914 Conflict Disclosures

Effective January 1, 2006, Texas Local Government Code Section 176.001, et seq. requires that all persons who seek to contract with a local governmental entity such as North Harris County Regional Water Authority (the "Authority") complete and submit a Conflicts of Interest Questionnaire (the "Questionnaire") to the Authority. The purpose of the Questionnaire is to disclose certain relationships a potential bidder or contractor may have with Board members or consultants of the Authority. Please complete the enclosed Questionnaire and submit it with the bid. To assist with completing the Questionnaire, we have included a list of the Authority's Board members and Officers in Section 00800, Attachment "C-1". **FAILURE TO COMPLETE AND SUBMIT THE QUESTIONNAIRE WILL RESULT IN THE BID BEING DECLARED INCOMPLETE AND COULD LEAD TO CRIMINAL LIABILITY.** In the discretion of the Authority, an incomplete bid resulting from the failure to complete and submit the Questionnaire by the bid submission deadline may be waived provided that the Questionnaire is completed and submitted prior to award of the contract by the Authority.

27. Texas Ethics Commission Form 1295

Effective January 1, 2016, pursuant to Texas Government Code § 2252.908 (the “Interested Party Disclosure Act” or the “Act”), the Authority may not award the contract to a BIDDER unless the BIDDER has provided to the Authority a completed, signed and notarized TEC Form 1295 which has been assigned a certificate number by the Texas Ethics Commission (the “TEC”). Pursuant to the rules prescribed by the TEC, the TEC Form 1295 must be completed online through the TEC’s website, assigned a certificate number, printed, signed and notarized, and provided to the Authority. **THE TEC FORM 1295 SHOULD ACCOMPANY THE BID.** For purposes of completing the TEC Form 1295, the entity’s name is North Harris County Regional Water Authority; the contract ID number is Project No. [___]; and the description of goods and services is [name of project]. Neither the Authority nor its consultants have the ability to verify the information included in a TEC Form 1295, and neither have an obligation nor undertake responsibility for advising any BIDDER with respect to the proper completion of the TEC Form 1295.

THE BIDDER UNDERSTANDS THAT FAILURE TO PROVIDE SAID FORM COMPLETE WITH A CERTIFICATE NUMBER ASSIGNED BY THE TEC WILL RESULT IN A NON-CONFORMING BID. In the discretion of the Authority, an incomplete bid resulting from the failure to complete and submit the completed TEC Form 1295 by the bid submission deadline may be waived provided that the form is completed and submitted prior to award of the contract by the Authority.

28. Texas Government Code Sec. 2270.002 and 2252 Compliance with Laws Prohibiting Contracts with Companies Boycotting Israel and Certain Companies Engaged in Business with Iran, Sudan or Foreign Terrorist Organizations:

By submitting a BID, BIDDER hereby verifies that BIDDER does not boycott Israel and will not boycott Israel during the term of the Contract. For purposes of this verification, “boycott Israel” means refusing to deal with, terminating business activities with, or otherwise taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations specifically with Israel, or with a person or entity doing business in Israel or in an Israeli-controlled territory, but does not include an action made for ordinary business purposes, as required by Section 2270.002, Texas Government Code.

Pursuant to Chapter 2252, Texas Government Code, the BIDDER represents and certifies that, at the time of execution of this Agreement, neither the BIDDER nor any wholly owned subsidiary, majority-owned subsidiary, parent company or affiliate of the same (i) engages in business with Iran, Sudan, or any foreign terrorist organization as described in Chapters 806 or 807 of the Texas Government Code, or Subchapter F of Chapter 2252 of the Texas Government Code, or (ii) is a company listed by the Texas Comptroller of Public Accounts under Sections 806.051, 807.051, or 2252.153 of the Texas Government Code. The term "foreign terrorist organization" in this paragraph has the meaning assigned to such term in Section 2252.151 of the Texas Government Code.

BIDDER acknowledges and agrees that the verification stated above is a material term of, and material consideration for, the Contract and that Owner is expressly relying on this verification in agreeing to enter the Contract with BIDDER.

END OF SECTION

BID

Date: _____

BID of _____, an individual proprietorship, a corporation authorized to transact business in Texas, or a partnership consisting of _____, registered to transact business in Texas _____

60-INCH AND 54-INCH WATERLINE ALONG GRANT ROAD AND COPELAND ROAD

PROJECT NO. 28-B

Work of the contract is for the construction of 60-Inch and 54-Inch Waterlines along Grant Road and Copeland Road using open cut and trenchless construction.

THIS BID IS SUBMITTED TO:

North Harris County Regional Water Authority
3648 Cypress Creek Pkwy., Suite 110
Houston, Texas 77068

1. The undersigned BIDDER proposes and agrees, if this BID is accepted, to enter into an agreement with OWNER in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Bid Price and within the Bid Times indicated in this BID and in accordance with the other terms and conditions of the Contract Documents. BIDDER accepts the terms of the form of Agreement and the Contract Documents.

2. BIDDER accepts all of the terms and conditions of the Invitation to BID and Instructions to Bidders including without limitation those dealing with the disposition of Bid Security. This BID will remain subject to acceptance for sixty (60) days after the day of BID opening. If BIDDER is the Successful Bidder, BIDDER will sign and deliver the required number of counterparts of the Agreement with the Bonds and other documents required by the Bidding Requirements within eight (8) days after the date of OWNER's Notice of Award.

3. In submitting this BID, BIDDER represents and warrants, as more fully set forth in the Agreement, that:

(a) BIDDER has examined and carefully studied the Bidding Documents and Addenda. BIDDER hereby acknowledges receipt of the following Addenda: (List Addenda by Addendum Number and Date).

Addendum No.: _____ Dated: _____

Addendum No.: _____ Dated: _____

Addendum No.: _____ Dated: _____

- (b) BIDDER has visited the site, has conducted all testing at the site BIDDER deems necessary, has become familiar with, has taken into consideration in formulating its BID, and accepts the general, local and site conditions that may affect cost, progress, performance, and furnishing of the Work;
- (c) BIDDER is familiar with, has taken into consideration in formulating its BID and accepts all federal, state, and local Laws and Regulations that may affect cost, progress, performance, and furnishing of the Work.
- (d) BIDDER has carefully studied all reports of explorations and tests of subsurface conditions at, or contiguous to, the site which have been identified in the Supplementary Conditions as provided in Paragraph 4.2.1 of the General Conditions. BIDDER accepts the determination set forth in Paragraph SC-4.2 of the Supplementary Conditions of the extent of the “technical data” contained in such reports upon which BIDDER is entitled to rely as provided in Paragraph 4.2 of the General Conditions. BIDDER understands, acknowledges, and agrees that such reports are not Contract Documents and may not be complete for BIDDER’s purposes. BIDDER understands, acknowledges, and agrees that OWNER, PROJECT MANAGER, and ENGINEER are not responsible for and make no warranties regarding the accuracy or completeness of information and data shown or indicated in the Bidding Documents with respect to surface and subsurface conditions and Underground Facilities at or contiguous to the site. BIDDER acknowledges that it has had the opportunity to obtain and study any and all such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work, or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by BIDDER, and safety precautions and programs incident thereto as may be necessary. BIDDER does not consider that any additional examinations, investigations, explorations, tests, studies or data are necessary for the determination of this BID for performance and furnishing of the Work in accordance with the times, price, and other terms and conditions of the Contract Documents.
- (e) BIDDER is aware of the general nature of work to be performed by OWNER and others at the site that relates to Work for which this BID is submitted as indicated in the Contract Documents.
- (f) BIDDER has correlated the information known to BIDDER, information and observations obtained from visits to the site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.
- (g) BIDDER has given PROJECT MANAGER written notice of all conflicts, errors, ambiguities, or discrepancies that BIDDER has discovered in the Contract Documents, and the written resolution thereof by ENGINEER is acceptable to BIDDER; BIDDER has no questions regarding the Work; BIDDER has all information necessary to make a fully informed BID; and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions

for performing and furnishing the Work for which this BID is submitted.

- (h) This BID is genuine and not made in the interest of or on behalf of any undisclosed person, firm, or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; BIDDER has not directly or indirectly induced or solicited any other BIDDER to submit a false or sham BID; BIDDER has not solicited or induced any person, firm, or corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for itself any advantage over any other BIDDER or over OWNER.
- (i) The Unit Prices in the Bid are not intentionally unbalanced so as to enable CONTRACTOR to receive periodic payments that will, by percentage, significantly exceed its percentage of overall completion on the Project.

4. BIDDER is duly qualified to carry on business in the State of Texas; possesses or has the ability to possess all licenses, permits, and certificates of authority necessary to commence and to complete the Work in accordance with the Bidding Documents; is fully qualified and has experience in performing work of the same type as the Work covered by the Bidding Documents; and will provide all necessary labor, superintendance, machinery, equipment, tools, materials, services, and other means of construction to complete all work upon which BIDDER bids and complete said work within the time stated and for maintaining same as required for the following prices:

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
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CLEARING AND GRUBBING ITEMS

1	6	Acre	Clearing and Grubbing, Including Removal and Off-Site Disposal, Complete in Place		
			@ _____		
			_____	\$ _____	\$ _____
			Per Acre		

SUBTOTAL CLEARING AND GRUBBING ITEMS

\$ _____

EROSION CONTROL ITEMS

2	12	Months	Pollution Prevention Implementation Including Maintenance, Inspections, and Reporting for All Pollution Prevention Measures as Shown on the Plans, Complete in Place		
			@ _____		
			_____	\$ _____	\$ _____
			Month		

3	11,660	Linear Foot	Furnish and Install Reinforced Filter Fabric Barrier per Plans and Specifications as Shown on Plans, Complete in Place		
			@ _____		
			_____	\$ _____	\$ _____
			Linear Foot		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
4	400	Linear Foot	Furnish and Install Reinforced Filter Fabric Barrier per Plans and Specifications, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		
5	2,800	Square Yard	Furnish and Install Stabilized Construction Access per Plans and Specifications, Complete in Place @ _____ _____	\$ _____	\$ _____
			Square Yard		
6	20	Each	Furnish and Install Curb Inlet Protection Barrier as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Each		
7	6	Acre	Furnish and Install Hydromulch Seeding of all Disturbed Areas, including fine grading as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Acre		
SUBTOTAL EROSION CONTROL ITEMS				\$ _____	

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
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WATER LINE ITEMS

8	1,350	Linear Foot	Furnish and Install 60-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____
9	250	Linear Foot	Furnish and Install 60-Inch Carrier Pipe in a Tunnel With Welded Steel Casing, Including Tunnel Shafts, Restrained Joints and Appurtenances as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____
10	6,675	Linear Foot	Furnish and Install 54-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
11	1,675	Linear Foot	Furnish and Install 54-Inch Carrier Pipe in a Tunnel With Welded Steel Casing, Including Tunnel Shafts, Restrained Joints and Appurtenances as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____
12	30	Linear Foot	Furnish and Install 16-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____
13	20	Linear Foot	Furnish and Install 12-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
14	100	Linear Foot	Furnish and Install 12-Inch Pipe by Auger and Casing, Including All Fittings and Appurtenances as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____
15	1	Each	Furnish and Install 60-Inch Butterfly Valve with Operator Manhole as Shown on Plans, Complete in Place @ _____ _____ Each	\$ _____	\$ _____
16	5	Each	Furnish and Install 54-Inch Butterfly Valve with Operator Manhole as Shown on Plans, Complete in Place @ _____ _____ Each	\$ _____	\$ _____
17	1	Each	Furnish and Install 12-Inch Gate Valve with Box as Shown on Plans, Complete in Place @ _____ _____ Each	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
18	16	Each	Furnish and Install 4-Inch Combination Air Release and Vacuum Relief Valve Assembly with Vent Piping, 3 Bollards and Service Manhole, as Shown on Plans, Complete in Place @ _____ _____ Each	\$ _____	\$ _____
19	6	Each	Furnish and Install Access Manway With Service Manhole as Shown on Plans, Complete in Place @ _____ _____ Each	\$ _____	\$ _____
20	82	Vertical Foot	Furnish and Install Extra Depth on Service Manhole as Shown on Plans, Complete in Place @ _____ _____ Vertical Foot	\$ _____	\$ _____
21	1	Each	Furnish and Install Connection 28-A Including Removal of 54-Inch Dish Head Plug as Shown on Plans, Complete in Place @ _____ _____ Each	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
22	1	Each	Furnish and Install Connection 28-C Including 60-Inch Dish Head Plug, Two 16-Inch Gate Valve and Box with Blind Flange Assemblies as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Each		
23	1	Each	Furnish and Install Connection 28-E Including One 16-Inch Gate Valve and Box and One 16-Inch Plug with 2-Inch Blow Off Valve as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Each		
24	1	Each	Furnish and Install Connection 28-F Including Two 16-Inch Gate Valve and Box with Blind Flange Assemblies as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Each		
25	1	Each	Furnish and Install 12-Inch Plug and Clamp as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Each		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
26	1	Each	Furnish and Install Flushing Hydrant Assembly, Including 6-Inch Gate Valve, Box and Tee as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Each		
27	8,075	Linear Foot	Furnish and Install Trench Safety System for Water Line Construction, as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		
			SUBTOTAL WATER LINE ITEMS	\$ _____	

PAVING ITEMS

28	340	Square Yard	Remove and Dispose of Asphaltic Surfacing including Base (all thicknesses) as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Square Yard		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
29	340	Square Yard	Furnish and Install Recycled Crushed Concrete Base Course as Shown on Plans, Complete in Place @ _____ _____ Square Yard	\$ _____	\$ _____
30	340	Square Yard	Furnish and Install Up to 2-Inch Thick Asphaltic Concrete Pavement as Shown on Plans, Complete in Place @ _____ _____ Square Yard	\$ _____	\$ _____
31	405	Square Yard	Remove and Dispose of Reinforced Concrete Pavement (all thicknesses), with or without Asphalt Overlay, with or without Curb, including Base and Subgrade as Shown on Plans, Complete in Place @ _____ _____ Square Yard	\$ _____	\$ _____
32	9	Ton	Furnish and Install Lime Stabilized Subgrade (dry weight) as Shown on Plans, Complete in Place @ _____ _____ Ton	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
33	405	Square Yard	Mix 8-Inch Lime Stabilized Subgrade as Shown on Plans, Complete in Place @ _____ _____ Square Yard	\$ _____	\$ _____
34	405	Square Yard	Furnish and Install up to 6-Inch Thick Reinforced Concrete Pavement as Shown on Plans, Complete in Place @ _____ _____ Square Yard	\$ _____	\$ _____
35	270	Linear Foot	Furnish and Install Curbs as Shown on Plans, Complete in Place @ _____ _____ Linear Foot	\$ _____	\$ _____
36	311	Square Yard	Remove and Dispose of Concrete Sidewalks (all thicknesses) and Driveways (all materials, all thicknesses) @ _____ _____ Square Yard	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
37	311	Square Foot	Furnish and Install Concrete Sidewalks, as Shown on Plans, Complete in Place @ _____ _____ Square Foot	\$ _____	\$ _____
PAVING SUBTOTAL ITEMS				\$ _____	

MISCELLANEOUS ITEMS

38	1	Lump Sum	Mobilization and Furnish Performance, Payment, and Maintenance Bonds in accordance with the Contract Documents _____ Lump Sum	\$ <u>275,000***</u>	\$ <u>275,000***</u>
39	1	Lump Sum	Furnish, Install, and Maintain Traffic Control Devices and Appurtenances, in Accordance With Texas Manual on Uniform Traffic Control Devices (Latest Edition), Including Flagmen, Complete in Place as Required @ _____ _____ Lump Sum	\$ _____	\$ _____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
40	1	Lump Sum	Furnish and Install Cathodic Protection per Specifications and as Shown on Plans, Complete in Place @_____	\$ _____	\$ _____

			Lump Sum		
41	2,395	Linear Foot	Remove and Dispose of Existing Fence (all types), as shown on Plans @_____	\$ _____	\$ _____

			Linear Foot		
42	1,563	Linear Foot	Furnish and Install 6-Foot Chain Link Fence to match existing as Shown on Plans, Complete in Place @_____	\$ _____	\$ _____

			Linear Foot		
43	225	Linear Foot	Furnish and Install 10-Foot Wood Fence to replace existing 6-Foot Wood Fence along Grant Road as Shown on Plans, Complete in Place @_____	\$ _____	\$ _____

			Linear Foot		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
44	50	Linear Foot	Furnish and Install 6-Foot Wood Fence to match existing as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		
45	165	Linear Foot	Furnish and Install 3-Strand Barb Wire Fence, to match existing, with Metal Posts and Gate, as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		
46	338	Linear Foot	Furnish and Install 6-foot Wrought Iron Fence, with brick columns, to match existing, as Shown on Plans, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		
47	1000	Linear Foot	Regrade Existing Ditches, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
48	50	Linear Foot	Furnish, Install, and Remove 24-Inch Reinforced Concrete Pipe, Complete in Place @ _____ _____	\$ _____	\$ _____
			Linear Foot		

SUPPLEMENTAL PAY ITEMS

**Minimum allowable prices. Bidder may choose to quote a higher price.

49	100	Square Yard	Furnish, Install, and Establish Extra Solid Sod, Complete in Place @ _____ _____	\$ _____ (\$5.00)**	\$ _____
			Square Yard		
50	8	Each	Furnish and Install Crushed Stone Manhole Foundation for Wet Conditions, Complete in Place @ _____ _____	\$ _____ (\$150.00)**	\$ _____
			Each		
51	100	Linear Foot	Furnish and Install Bedding and Backfill for Wet Conditions, Complete in Place @ _____ _____	\$ _____ (\$15.00)**	\$ _____
			Linear Foot		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
52	50	Cubic Yard	Furnish and Install Extra Class "A" Concrete With Reinforcing Steel, Complete in Place @ _____ _____	\$ _____ (\$265.00)**	\$ _____
			Cubic Yard		
53	50	Pound	Furnish and Install Extra Reinforcing Steel, Complete in Place @ _____ _____	\$ _____ (\$50.00)**	\$ _____
			Pound		
54	100	Cubic Yard	Furnish and Install Extra Bank Sand Backfill, Complete in Place @ _____ _____	\$ _____ (\$18.00)**	\$ _____
			Cubic Yard		
55	100	Cubic Yard	Furnish and Install Extra Cement Stabilized Sand, Complete in Place @ _____ _____	\$ _____ (\$24.00)**	\$ _____
			Cubic Yard		

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
56		Each	Furnish and Install Extra 54-Inch Water Line Fitting, All Angles, Complete in Place @_____	\$_____	\$_____
			Ton	(\$1,000)**	
57		Each	Furnish and Install Extra 60-Inch Water Line Fitting, All Angles, Complete in Place @_____	\$_____	\$_____
			Ton	(\$1,000)**	
58		Ton	Furnish and Install Extra 16-Inch Water Line Fitting, All Angles, Complete in Place @_____	\$_____	\$_____
			Ton	(\$500.00)**	
59		Ton	Furnish and Install Extra 12-Inch Water Line Fitting, All Angles, Complete in Place @_____	\$_____	\$_____
			Ton	(\$500.00)**	
SUBTOTAL SUPPLEMENTAL PAY ITEMS				\$_____	

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
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CASH ALLOWANCE ITEMS

***Maximum Allowable Bid Price, Bidder may not change.

60	NA	NA	Allowance for Harris County Permits, Reimbursed on an Actual Cost Basis @ _____ _____		<u>\$20,000.00</u>
61		NA	Cash Allowance for Approved Construction Modifications, Reimbursed in Accordance with Article 10 of Section 00700 of the General Conditions. @ _____ _____		<u>(Amount 5% of Construction Cost)***</u>
SUBTOTAL CASH ALLOWANCE ITEMS				\$	_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.

**Minimum allowable prices. Bidder may choose to quote a higher price.

***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
TOTAL AMOUNT BID			\$ _____		
TOTAL AMOUNT FOR MATERIALS			\$ _____		
TOTAL AMOUNT FOR SKILLS, LABOR, EQUIPMENT, ETC.:			\$ _____		

The OWNER in its continuing partnership with the Texas Water Development Board (TWDB) is enlisting the assistance of the BIDDER in obtaining contractor cost data on the cost of compliance with TWDB-1105, Rev 11/07/2018 “United States Iron and Steel (US I&S) Guidance for Projects Funded through State Programs” (See Attachment of TWDB-1105 in Section 00800 “Supplementary Conditions”). In this regard the OWNER requires the BIDDER provide the LUMP SUM compliance cost on this Project to be used for information purposes only.

Lump Sum	Cost of Compliance with TWDB-1105, Rev 11/07/2018 - United States Iron and Steel (US I&S) Guidance for Projects Funded through State Programs		
	@ _____		
	_____	\$ _____	\$ _____
	Lump Sum		

*In the event of a discrepancy, figures in the ‘UNIT PRICE’ column govern.
 **Minimum allowable prices. Bidder may choose to quote a higher price.
 ***Maximum allowable bid price. Bidder may not change.

North Harris County Regional Water Authority

The undersigned (Contractor) represents and warrants that (1) all tangible personal property identified as ‘materials’ in the Proposal will be incorporated into Project, subject only to field adjustments as to quantities, (2) the prices of such material are exclusive of sales and use taxes, and (3) all sales and use taxes regarding tangible personal property not incorporated into the work are the sole responsibility of the Contractor and the Contractor has paid or will pay such taxes regarding such property.

Acknowledge receipt of Addendum Nos. _____, _____, _____
(initial)

ALL BID PRICES SHALL INCLUDE ALL APPLICABLE SALES
TAX

5. BIDDER agrees to begin work promptly after written Notice to Proceed is given by OWNER and will substantially complete the Work within 335 days in accordance with Paragraph 15.5 of the General Conditions and will complete the Work and be ready for final payment within 365 days after the date of the written Notice to Proceed in accordance with Paragraph 15.9 of the General Conditions.

BIDDER accepts all the provisions of the Agreement and the Contract Documents, including the provision for liquidated damages in the event of failure to complete the Work within the time specified in the Agreement.

6. BIDDER has enclosed with this BID the required Bid Security in the form of a _____ in the amount of \$ _____. BIDDER agrees that this amount is a measure of liquidated damages which OWNER will sustain by failure of the BIDDER to execute and deliver above named Agreement and Bonds, and not a penalty, and further agrees that this Bid Security shall be collected and retained by OWNER as liquidated damages in the event this BID is accepted by OWNER within sixty (60) days after opening of Bids, and BIDDER fails to execute the Agreement and the required Bonds with OWNER within eight (8) days after Contract Documents are received by BIDDER; otherwise said Bid Security shall be returned to the BIDDER in accordance with Paragraph 7 of Section 00100 - Instruction to Bidders.

7. BIDDER has enclosed with this BID the required HB 194 Conflict Disclosures form, which is located in Section 00800 – Supplementary Conditions, Attachment C-1.

(THIS SPACE INTENTIONALLY LEFT BLANK)

North Harris County Regional Water Authority

ATTEST:

Very truly yours

(SEAL, if Bidder is Corporation)

By: _____
(Signature)

(Typed or Printed Name)

Title: _____

Bidder: _____
(Name of Company)

Address: _____

Telephone No.: _____

Facsimile No.: _____

Surety Company: _____

Address: _____

Telephone No.: _____

Facsimile No.: _____

AGREEMENT

THIS AGREEMENT is dated as of the _____ day of _____ in the year _____ by and between North Harris County Regional Water Authority (hereinafter called OWNER) and _____ (hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

Article 1. WORK.

1.1. CONTRACTOR shall perform the Work in a good and workmanlike manner and in the best way and most expeditious and economical manner consistent with the interests of the OWNER, shall exercise the degree of care, skill, and diligence in the performance of the Work in accordance with and consistent with industry standards for similar circumstances, shall utilize its best skill, efforts, and judgment in furthering the interests of the OWNER, and shall furnish efficient business administration and supervision (collectively, CONTRACTOR's "Standard of Care").

1.2. CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

Clearing and Grubbing, construction of erosion control measures, construction of 60-Inch and 54-Inch Water Transmission Line by trenchless and open-cut methods, construction of 16-Inch District waterlines and site restoration.

Article 2. PROJECT MANAGER AND ENGINEER.

2.1 PROJECT MANAGERS.

AECOM Technical Services, Inc. has been designated as the PROJECT MANAGER and is to assume all duties and responsibilities assigned to PROJECT MANAGER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

2.2 ENGINEER.

The Project has been designed by Dannenbaum Engineering Corp., who is to assume all duties and responsibilities assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

Article 3. CONTRACT TIMES.

3.1. The Work will be substantially completed within 335 days after the date when the Contract Times commence to run as provided in Paragraph 2.3 of the General Conditions and will be completed and ready for final payment in accordance with Paragraph 15.9 of the General Conditions within 365 days after the date when the Contract Times commence to run.

3.2. *Liquidated Damages.* OWNER and CONTRACTOR recognize that time is of the essence to this Agreement and that OWNER will suffer financial loss if the Work is not completed within the times specified in Paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense, and difficulties involved in proving the actual loss suffered by OWNER if the Work is not completed on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty), CONTRACTOR shall pay OWNER Two Thousand_dollars (\$2,000) for each day that expires after the time specified in Paragraph 3.1 above for Substantial Completion until the Work is substantially complete. After Substantial Completion, if CONTRACTOR shall neglect, refuse, or fail to complete the remaining Work within the time specified in Paragraph 3.1 above for completion and readiness for final payment or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER Two Thousand_dollars (\$2,000) for each day that expires after the time specified in Paragraph 3.1 for completion and readiness for final payment.

Article 4. CONTRACT PRICE.

OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts as indicated in the Bid, Section 00300.

As provided in Paragraph 11.4.1 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classification are to be made by PROJECT MANAGER as provided in Paragraph 9.7 of the General Conditions. Unit prices have been computed as provided in Paragraph 11.4 of the General Conditions.

Article 5. PAYMENT PROCEDURES.

CONTRACTOR shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by the PROJECT MANAGER as provided in the General Conditions.

5.1. *Progress Payments; Retainage.* Subject to OWNER's right to withhold payment in Paragraph 15.4.4 of the General Conditions, OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's completed Applications for Payment as recommended by PROJECT MANAGER, on or about the 25th day of each month during construction as provided in Paragraphs 5.1.1. and 5.1.2. below. All such payments will

be measured by the schedule of values established in Paragraph 2.4.2.3 of the General Conditions (and in the case of Unit Price Work based on the number of units completed).

5.1.1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below, but, in each case, less the aggregate of payments previously made and less such amounts as PROJECT MANAGER shall determine, or OWNER may withhold, in accordance with Paragraph 15.4.4 of the General Conditions.

95 percent of Work completed and included in the Application for Payment (with the balance being retainage).

85 percent (with the balance being retainage) of materials and equipment not incorporated in the Work (but delivered, suitably stored and accompanied by documentation satisfactory to OWNER as provided in Paragraph 15.2 of the General Conditions) and included in the Application for Payment.

5.1.2. Upon Substantial Completion and submission of a completed Application for Payment, in an amount sufficient to increase total payments to CONTRACTOR to 98 percent of the Contract Price (with the balance being retainage), less such amounts as PROJECT MANAGER shall determine, or OWNER may withhold, in accordance with Paragraph 15.4.4 of the General Conditions.

5.2. *Final Payment.* Upon final completion and acceptance of the Work in accordance with Paragraph 15.9 of the General Conditions and submission of a completed Application for Payment, OWNER shall pay the remainder of the Contract Price as recommended by PROJECT MANAGER as provided in said Paragraph 15.9.

Article 6. NOT USED

Article 7. CONTRACTOR'S REPRESENTATIONS.

In order to induce OWNER to enter into this Agreement, CONTRACTOR makes the following representations and warranties:

7.1. CONTRACTOR has examined and carefully studied the Contract Documents (including the Addenda listed in Article 8) and the other related data identified in the Bidding Documents including "technical data."

7.2. CONTRACTOR has visited the site, has conducted all testing at the site CONTRACTOR deems necessary, has become familiar with, has taken into consideration in formulating its BID, and accepts the general, local, and site conditions that may affect cost, progress, performance and furnishing of the Work;

7.3. CONTRACTOR is familiar with and has taken into consideration in formulating its BID and accepts all federal, state, and local Laws and Regulations that may affect cost, progress, performance, and furnishing of the Work.

7.4. CONTRACTOR has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the site which have been identified in the Supplementary Conditions as provided in paragraph 4.2.1 of the General Conditions. CONTRACTOR accepts the determination set forth in paragraph SC-4.2 of the Supplementary Conditions of the extent of the “technical data” contained in such reports and drawings upon which CONTRACTOR is entitled to rely as provided in paragraph 4.2 of the General Conditions. CONTRACTOR understands, acknowledges, and agrees that such reports are not Contract Documents and may not be complete for CONTRACTOR’s purposes. CONTRACTOR understands, acknowledges, and agrees that OWNER, PROJECT MANAGER, and ENGINEER are not responsible for and make no warranties regarding the accuracy or completeness of information and data shown or indicated in the Bidding Documents with respect to surface and subsurface conditions. CONTRACTOR has obtained and carefully studied and is responsible for obtaining and studying any and all such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work or which relate to any aspect of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto as may be necessary. CONTRACTOR does not consider that any additional examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance and furnishing of the Work in accordance with the times, price and other terms and conditions of the Contract Documents.

7.5. CONTRACTOR is aware of the general nature of work to be performed by OWNER and others at the site that relates to Work for which this BID is submitted as indicated in the Contract Documents.

7.6. CONTRACTOR has correlated the information known to CONTRACTOR, information and observations obtained from visits to the site, reports and PLANS identified in the Contract Documents and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

7.7. CONTRACTOR has given PROJECT MANAGER written notice of all conflicts, errors, ambiguities or discrepancies that CONTRACTOR has discovered in the Contract Documents, and the written resolution thereof by PROJECT MANAGER is acceptable to CONTRACTOR, CONTRACTOR has no questions regarding the Work, CONTRACTOR has all information necessary to make a fully informed BID, and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this BID is submitted.

7.8. CONTRACTOR represents and warrants that CONTRACTOR (i) is qualified and experienced, (ii) is capable of performing the Work and has available resources to perform the Work, and (iii) understands and agrees to the terms of all of the Contract Documents.

Article 8. CONTRACT DOCUMENTS.

North Harris County Regional Water Authority

The Contract Documents that comprise the entire agreement between OWNER and CONTRACTOR concerning the Work consist of the following:

- 8.1. This Agreement (pages 1 to 8, inclusive).
- 8.2. Bid Form (pages 1 to 23, inclusive) marked Section 00300.
- 8.3. Construction Performance Bond, Payment Bond, and One-Year Maintenance Bond, identified as Sections 00610, 00620, and 00630 consisting of 4, 2, and 4 pages, respectively.
- 8.4. Other Exhibits to this Agreement (pages N\A to N\A, inclusive) (if any).
- 8.5. Notice to Proceed.
- 8.6. General Conditions (pages i to 60, inclusive), marked Section 00700.
- 8.7. Supplementary Conditions (pages 1 to 6, inclusive), marked Section 00800.
- 8.8. Specifications, bearing the title 60-INCH AND 54-INCH WATERLINE ALONG GRANT ROAD AND COPELAND ROAD PROJECT NO. 28-B and consisting of 1 volumes, as listed in table of contents thereof.
- 8.9. PLANS consisting of a cover sheet and sheets numbered 1 through 99 inclusive with each sheet bearing the following general title: North Harris County Regional Water Authority, Project 28-B Proposed 60" and 54" Water Line Along Grant Road and Copeland Road.

The documents listed in Article 8.2 et seq. above are attached to this Agreement (except as expressly noted otherwise above).

There are no Contract Documents other than those listed above in this Article. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraphs 3.3.1 and 3.3.2 of the General Conditions.

Article 9. MISCELLANEOUS.

- 9.1. Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meanings indicated in the General Conditions.
- 9.2. No assignment by CONTRACTOR of any rights under or interests in the Contract Documents will be binding on OWNER or effective without the prior written consent of the OWNER; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

9.3. OWNER and CONTRACTOR each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

9.4. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon OWNER and CONTRACTOR, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision. If, however, the void or unenforceable provision is of the essence of this Agreement, nothing in this Paragraph 9.4 shall prevent this entire Agreement from being void.

9.5. OTHER PROVISIONS. As noted hereinafter:

9.5.1. The following Articles shall survive termination of this Agreement: 3 (Contract Times); 7 (Contractor's Representations); and 9 (Miscellaneous).

9.5.2. Headings and titles of Articles in this Agreement are included herein for convenience of reference only and shall not constitute a part of the Agreement for any other purpose and will not affect in any way the meaning or interpretation of this Agreement.

9.5.3. This Agreement as executed by authorized representatives of OWNER and CONTRACTOR constitutes the entire Agreement between the parties with respect to matters herein, and there are no oral or written understandings, representations, or commitments of any kind, express or implied, not expressly set forth herein.

9.5.4. This Agreement, its interpretation, and any disputes relating to, arising out of, or connected with this Agreement, shall be governed by the laws of the State of Texas, without regard to conflicts of law provisions. Any dispute relating to, arising out of, or connected with this Agreement shall be filed and maintained in the state or federal courts located in Harris County, Texas, unless otherwise agreed by the parties in connection with an Alternative Dispute Resolution Agreement.

9.5.5. Each party hereto represents and warrants that the person executing this Agreement on its behalf is duly authorized and empowered to do so and that all formalities necessary for its approval of this Agreement have been satisfied.

9.5.6. CONTRACTOR undertakes performance of the Work as an independent contractor. Nothing herein shall create a relationship of employer and employee, joint venture, or partnership between OWNER and CONTRACTOR, its agents, representatives, employees, or subcontractors for any purpose whatsoever. Nothing herein shall create a relationship of principal and agent between OWNER and CONTRACTOR, its agents, employees, representatives, or subcontractors. Neither party shall have the authority to bind or obligate the other in any manner as a result of the relationship created hereby.

9.5.7. Upon payment of a portion of the Work, CONTRACTOR shall be deemed to have sold and conveyed to OWNER, and OWNER shall be deemed to have purchased from CONTRACTOR all of CONTRACTOR's right, title, and interest in the Work. From and after the date of such payment, within fifteen (15) days of the request of OWNER, CONTRACTOR shall execute and deliver such bills of sale and other instruments of conveyance, assignment, transfer, and delivery as OWNER may reasonably request in order to convey such right, title, and interest to OWNER. From and after the date of such payment, title to the Work shall remain with OWNER.

9.5.8. CONTRACTOR fully understands, and will assure that its subcontractors and suppliers fully understand that OWNER is a public entity and thus (1) an entity against which no mechanics lien may be asserted, and (2) an entity that can be bound only by agents with actual authority and (3) an entity that can only be bound to make payments from funds actually available for the performance of this Agreement.

9.5.9. Waiver of any breach of the Contract shall not constitute waiver of a subsequent breach.

9.5.10. Although the Contract Documents have been largely drafted by OWNER, in the event of any disputes over meaning and application, the Contract Documents shall be interpreted fairly and reasonably neither more strongly for nor against either party.

North Harris County Regional Water Authority

IN WITNESS WHEREOF, OWNER and CONTRACTOR have signed this Agreement in triplicate. One counterpart each has been delivered to OWNER, CONTRACTOR, and PROJECT MANAGER. All portions of the Contract Documents have been signed, initialed, or identified by OWNER and CONTRACTOR or identified by PROJECT MANAGER on their behalf.

This Agreement will be effective on _____, (which is the Effective Date of the Agreement).

OWNER North Harris County CONTRACTOR _____
Regional Water Authority _____

By: _____ By: _____

[CORPORATE SEAL]

[CORPORATE SEAL]

Attest _____ Attest _____

Address for giving notices Address for giving notice
3648 Cypress Creek Pkwy, Suite 110 _____
Houston, TX 77068 _____

(OWNER is public body. Evidence of authority to sign and resolution or other documents authorizing execution of Agreement is attached.)

If CONTRACTOR is a corporation, attach evidence of authority to sign).

APPROVED:

Mr. Jimmie Schindewolf, P.E.
General Manager

END OF SECTION

Section 02400

TUNNEL SHAFTS

PART 1 GENERAL

1.01 SUMMARY

This Section includes construction, maintenance, and backfilling requirements of tunnel shafts.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Tunnel shafts, both those shown on Plans and those additional ones needed for Contractor's operations, are incidental to tunnel construction and no separate payment will be made for them. Manholes constructed in tunnel shafts are to be paid separately at contract unit price as specified in Section 02081 – "Cast-in-place Concrete Manholes" or Section 02082 – "Precast Concrete Manholes".
2. Removal and replacement of surface improvements necessary for shaft construction, such as sidewalks, asphaltic or concrete pavement, base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydro-mulch are incidental to tunnel construction and no separate payment will be made for them.

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 (NOT USED)

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 – "Submittal Procedures".

B. Shaft design submittals by Contractor shall be signed and sealed by Professional Engineer registered in State of Texas. If trench box is used in tunnel shaft and such utilization is in a manner other than what is indicated and certified in manufacturers technical data, submit trench box manufacturer certification of proposed usage.

C. Submit shaft construction drawings and seal slabs. Clearly indicate allowable surcharge loads and restrictions on surcharge capacity, including live loads, on shaft construction drawings. Indicate thrust blocks or other reactions required for pipe jacking, when applicable.

1. Location of shafts by station and limits of working sites.
 2. Description of site security arrangements in conformance with Paragraph 3.03.C, Shaft Construction.
 3. Description of method of extending shaft above flood level in conformance with Paragraph 3.03.C, Shaft Construction.
 4. Any geotechnical/boring undertaken by Contractor for whatever purpose connected to Work.
- D. Shaft Monitoring Plan: Submit for review prior to construction, shaft monitoring plan that includes schedule of instrumentation design, layout of instrumentation parts, equipment installation details, manufacturer's catalog literature, and monitoring report forms.
- E. Structures Assessment. Provide preconstruction and post-construction assessment reports for critical structures located within radius of shaft center equal to shaft depth plus shaft radius, measured in plan. Include photographs or video of any existing damage to structures in vicinity of shafts in assessment reports.
- F. Submit shaft surface settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.
- G. Submit readings of monitoring plans to Project Manager as soon as readings have been taken.
- H. Submit shaft temporary deck drawings and calculations to Project Manager, signed and sealed by Contractor's Professional Engineer in event that shaft is not needed for immediate construction activity, in conformance with Paragraph 3.03.C, Shaft Construction.
- 1.05 RELATED REQUIREMENTS
- A. Section 01300 – "Submittal Procedures"
 - B. Section 01504 – "Temporary Facilities and Controls"
 - C. Section 01555 – "Traffic Control and Regulation"
 - D. Section 01576 – "Waste Material Disposal"
 - E. Section 01578 – "Control of Ground Water and Surface Water"
 - F. Section 02081 – "Cast-In-Place Concrete Manholes"

- G. Section 02082 – “Precast Concrete Manholes”
 - H. Section 02316 – “Excavation and Backfill for Structures”
 - I. Section 02317 – “Excavation and Backfill for Utilities”
 - J. Section 02321 – “Cement Stabilized Sand”
 - K. Section 02431 – “Tunnel Grout”
- 1.06 QUALITY ASSURANCE (NOT USED)
- 1.07 SYSTEM DESCRIPTION
- A. Performance Requirements
 - 1. Shaft design must include allowance for contractor’s equipment and stored material and spoil stockpile as appropriate. Design must also allow for HS-20 highway loading if located in the vicinity of a paved area and/or allow for Cooper E-80 locomotive loading if located in the vicinity of a railroad.
 - 2. Design shaft to withstand full hydrostatic head without failure.
 - 3. Design shaft located within 50-year flood plain with water retaining liner extending 2 feet above 50-year flood elevation. It is acceptable when liner is stored at site for immediate installation in lieu of it being installed at shaft, provided that shaft liner extends at least 2 feet above existing ground elevation.
 - 4. Design shaft cover for minimum 25 pounds per square foot distributed load plus 300-pound point load.
 - 5. Design steel plate deck, if such is required, for HS-20 loading.
- 1.08 – 1.13 NOT USED
- PART 2 PRODUCTS (NOT USED)
- PART 3 EXECUTION
- 3.01 – 3.02 NOT USED
- 3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION
- A. Location of Access Shafts

1. Contractor has sole responsibility for selection of shaft sites needed for construction operations unless otherwise indicated on Plans. Location will be subject to approval of the Project Manager.
 2. Locate shafts and associated Work areas to avoid blocking driveways and cross streets, and to minimize disruption to business and commercial interests. Avoid shaft locations near areas identified as residential or potentially contaminated.
 3. Plan shaft locations to minimize interference with storm drainage channels, ditches, water lines, sanitary sewers, storm water sewers or culverts, which, when damaged, could result in ground washout or flooding of shafts and tunnels.
- B. Utility Relocation
1. Relocate utilities as shown on Plans. Utility relocations required by Contractor for shaft construction shall take into account zone of potential settlement in vicinity of shaft.
 2. Obtain approval from Project Manager for permanent relocations prior to relocating.
- C. Shaft Construction
1. Conform to the following for ground support systems:
 - a. Install liner elements, bracing and shoring structural members at locations and in method sequence and tolerances defined on shaft construction drawings as excavation progresses.
 - b. Ensure bracing and shoring are in contact with liner to provide full support as shown in shaft construction drawings. Evaluate and check modifications to liner, bracing, and shoring. Obtain approval from Contractor's Professional Engineer and submit to Project Manager.
 - c. Install seal slab as soon as final depth and stable bottom conditions have been reached and accepted by Project Manager. Construct seal slab capable of withstanding full piezometric pressure, either by pressure relief using under drains, or in case of more permeable ground condition, by use of structural reinforced slab. Construct seal slab in accordance with design provided by Contractor's Professional Engineer.
 - d. Design and construct entire shaft to appropriate factors of safety against yield, deformation, or instability as determined by Contractor's

- Professional Engineer. Shaft must withstand full hydrostatic head without failure.
- e. Special framing, bracing or shoring required around tunnel “eyes” or other penetrations shall be in-place according to shaft construction drawings before liner or any bracing or shoring at penetration is cut or removed.
 - f. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.
 - g. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels in accordance with Section 02431- “Tunnel Grout”. Pressure grout bolted steel liner plates as they are installed, unless otherwise approved by Project Manager. Perform secondary or ‘back grouting’ as ground measurement, voids, or deformation of shaft liner are detected.
2. Install suitable thrust or reaction blocks as required for pipe jacking equipment.
 3. Provide drainage from shafts while Work is in progress and until adjacent pipe joints have been sealed and shaft is backfilled. Conform to requirements of Section 01578 – “Control of Ground Water and Surface Water”.
 4. Surface Water Control. Divert surface water runoff and discharge from dewatering system away from shaft. Protect shafts from infiltration or flooding.
 5. Each surface work site is to be surrounded by security fence meeting requirements of Section 01504 – “Temporary Facilities and Controls”, which shall be secure any time site is unattended by Contractor’s personnel.
 6. Protect shaft, when not in use by second security fence at perimeter of shaft, or alternatively by cover designed in accordance with Paragraph 1.07.A, Performance Requirements.
 7. Provide portable concrete traffic barriers at locations where work site is situated adjacent to highway, road, driveway, or parking lot. Angle traffic barriers in direction of lane flow. Do not place perpendicular to on-coming traffic.
 8. Provide and maintain traffic control system in accordance with provision of Section 01555 – “Traffic Control and Regulation”.
 9. Cover shaft which is constructed more than 60 days in advance of its intended use by steel plate deck designed by Contractor’s Professional Engineer, and

restore surface to permit full traffic flow during time shaft is not in use. Remove from site other material and equipment used by Contractor including portable concrete traffic barriers, traffic control system, fencing and reinstall at time shaft is re-opened for use.

10. Construct suitable guardrail barrier around periphery of shaft, meeting applicable safety standards. Properly maintain barrier throughout period shaft remains open. Repair broken boards, supports, and structural members. Provide ladder with safety cage when required by OSHA in each shaft. In addition, provide full cover or other security barrier for each access shaft in which there is no construction activity or which is unattended by Contractor's personnel.
11. Size of Shafts: Make size adequate for construction of permanent structures indicated on Plans and to provide adequate room to meet operational requirements for tunnel construction and backfill.

D. Backfill

1. Provide cement-stabilized sand to minimum depth of 10 feet above crown of pipe, but where shaft is located in paved area, cement-stabilized sand shall be used to within one foot of pavement subgrade elevation. Provide cement-stabilized sand in accordance with Section 02321 – "Cement-stabilized Sand". Compact cement-stabilized sand in accordance with Section 02317 – "Excavation and Backfill for Utilities". In locations where backfill is not subject to traffic loading, depth above initial cement-stabilized sand may be backfilled with select backfill in accordance with Section 02316 – "Excavation and Backfill of Structures". When insufficient work space exists, Grout manhole or structure annular space in accordance with Section 02431 – "Tunnel Grout".
2. Remove shaft liner above level of 8 feet below ground surface, unless otherwise indicated on Plans. Maintain sufficient ground support to meet excavation safety requirements while removing shaft structure.

E. Monitoring

1. Monitoring Instrumentation. Instrumentation specified and readings shall be accessible at all times to Project Manager.
 - a. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical survey control points at distance from construction area that avoids disturbance due to ground settlement.

- b. Project Manager may through independent contractor or consultant, install instrumentation in, on, near, or adjacent to construction work. Provide access to Work for such independent installations.
 - c. Install instruments in accordance with Plans and manufacturer's recommendations.
2. Surface Settlement Monitoring
- a. Establish monitoring points on all critical structures.
 - b. Record location of 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 points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.
 - c. Monitoring points to measure ground elevation are required at distance of 10 feet and 20 feet from perimeter of shaft on each of four radial lines, at 90 degrees to each other.
 - d. Railroads. Monitor ground settlement of track subbase at centerline of each track when within zone of potential settlement.
3. Reading Frequency and Reporting. Submit to Project Manager, records of readings from various instruments and survey points.
- a. Record all shaft monitoring readings at least once per week starting prior to shaft construction and continuing until shaft has been backfilled and until no more detectable movement occurs.
 - b. Immediately report to Project Manager any movement, cracking, or settlement which is detected.
 - c. Following substantial completion but prior to final completion, make final survey of all shaft related monitoring points.

F. Disposal of Excess Material

Remove spoil in accordance with Section 01576 – “Waste Material Disposal”.

3.04 – 3.10 NOT USED

END OF SECTION

SECTION 02425

TUNNEL EXCAVATION AND PRIMARY LINER

PART 1 GENERAL

1.01 SUMMARY

This 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.
- B. Construction Methods: Various construction methods such as TBM, hand tunneling, or shield are allowed. Liners include rib and lagging, steel liner plate, bolted steel liner etc. Liners may be expanded or grouted.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for Work performed under this Section such as excavation, liner, grouting, instrumentation, or monitoring. Include cost of tunnel excavation and primary liner in accordance with Section 02511 – “Water Lines”.
- 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.
- D. 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. 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/A36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM A1064/1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - c. ASTM A283/A283M – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - d. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - e. ASTM A328/A328M – Standard Specification for Steel Sheet Piling.
 - f. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - g. ASTM C33/C33M – Standard Specification for Concrete Aggregates.
4. ASTM C150/C150M – Standard Specification for Portland Cement. American Water Works Association (AWWA)
- a. AWWA C206 – Field Welding of Steel Water Pipe.
 - b. 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 SUBMITTALS

- A. Procedures: Conform to requirements of Section 01330 – “Submittal Procedures”. Project Manager will review plans, details, and data for compliance with requirements of the 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 Project Manager. All structural designs and other engineered components must be signed and sealed by Professional Engineer registered in the State of Texas.
- B. Tunneling Work Plan: Submit to Project Manager 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. Submit sufficiently detail construction drawings and descriptions to demonstrate to

Project Manager whether proposed materials and procedures will meet requirements of Specification, as indicated below:

1. Submit Contractor's work plan and construction drawings on following items, depending on method of construction:
 - 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 (including modifications), experience record with this type of machine of both Contractor and proposed operator and copy of manufacturer's operation manual for machine.
 - b. The Contractor may elect to use tunnel shield that is separate from mechanized excavation equipment or for use with hand excavation. When use of tunnel shield is proposed, 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.
 - j. Special activities at critical utility crossings, or for Work potentially affecting other facilities and existing utilities where special precautions must be taken during construction.
2. Submit design criteria established by Contractor's Engineer for primary liner, including design calculations and installation details, and certification by qualified Professional Engineer registered in the State of Texas that structural

- design of primary tunnel meets criteria and specified requirements for range of field conditions.
3. Submit layout and design of proposed access shafts and shafts for permanent installations in accordance with Section 02400 – “Tunnel Shafts”.
 4. Submit ground water and surface water control system details per requirements in this Section and in accordance with Section 01578 – “Control of Ground Water and Surface Water”.
 5. All structural designs 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: Submit description of quality control methods Contractor proposes to use in this operation to Project Manager. Include in submittal the following items:
1. Supervision: Supervisory control to ensure that Work is performed in accordance with Plans 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 3.05, Tunneling Data and 3.06, Control of Tunnel Line and Grade of this Section.
 4. Monitoring Instrumentation: Conform to requirements of Paragraph 3.08A, Monitoring Instrumentation of this Section.
 5. Settlement Survey Plan, to meet requirements of Paragraph 3.08C, Settlement Surveying of this Section. This plan may be submitted as part of Instrumentation Monitoring Plan.
 6. Building Condition/Assessment Plans: Conform to requirements of Paragraph 3.08B, Buildings and Structures Assessment of this Section.
- D. Geotechnical and Environmental Investigation: Include results of geotechnical and environmental investigations performed by Contractor as relevant to tunneling in Work Plan. Submit these reports to the Project Manager for record purposes only.
- E. Safety: Submit to Project Manager procedures to meet all applicable OSHA requirements including the following as minimum: Submit these procedures for record purpose only.

1. Protection against soil instability and ground water inflow.
2. Safety for shaft access and exit including ladders, stairs, walkways, and hoists.
3. Means of mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.
4. Ventilation, lighting, and communication systems.
5. Monitoring for hazardous gases.
6. Protection against flooding.
7. Means for emergency evacuation.
8. Protection of shaft including traffic barriers, accidental or unauthorized entry, and falling objects.
9. Emergency protection equipment and self-rescue equipment.
10. Safety supervising responsibilities.

1.05 RELATED REQUIREMENTS

- A. Section 01330 – “Submittal Procedures”
- B. Section 01504 – “Temporary Facilities and Controls”
- C. Section 01578 – “Control of Ground Water and Surface Water”
- D. Section 02400 – “Tunnel Shafts”
- E. Section 02431 – “Tunnel Grout”
- F. Section 02511 – “Water Lines”
- G. Section 02517 – “Water Line in Tunnels”
- H. Section 02518 – “Steel Pipe and Fittings for Large Diameter Water Lines”
- I. Section 02621 – “Geotextile”
- J. Design Criteria
 1. 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. Contractor responsible for design of primary liner to carry thrust of jacking or

other construction forces or loads anticipated. Contractor's Professional Engineer is responsible for design of primary tunnel liner system.

2. At railroad crossings, unless otherwise specified by railroad authority use Cooper E-80 locomotive loading distribution criteria in accordance with AREMA specifications for culverts. 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.
3. Use HS-20 vehicle loading distributions for truck loading criteria in accordance with AASHTO.
4. Compatibility of Methods:
 - a. Use compatible methods of excavation, liner, and ground stabilization and ground water control.
 - b. 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.
 - c. Use compatible tunneling method with possible restrictions on Work, such as influence on existing installations or potential ground water contamination.
5. Demonstrate that chosen method will prevent flow of water or soil into tunnel and provide stability of face under anticipated conditions.

1.06 – 1.08 NOT USED

1.09 PROJECT SITE 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 a day, including weekends and holidays, without intermission until potentially hazardous conditions no longer exist or jeopardizes stability and safety of Work or existing installations.

3. Perform tunnel construction in a manner that shall minimize 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 a 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 shall positively control dust, fumes, vapors, gases, or other atmospheric impurities in accordance with OSHA, Federal, State, and City 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. Submit results of air quality tests to Project Manager.
- D. Ground Conditions: Perform sufficient exploration by geotechnical and environmental borings in 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 and environmental investigations in related work plans.

1.10 DEFINITIONS

- A. Tunneling Work Plan is defined as written description together with sketches, drawings, schedules, and other documents defining Contractor's planned methods and procedures for tunneling operations.
- B. Contractor's Construction Drawings are defined as drawings by which Contractor proposes to furnish, construct, install, and operate referenced item.
- C. Primary Liner is defined as Contractor's initial construction liner and tunnel support installed by Contractor for ground stability and safety during construction in

preparation for the installation of water line. Contractor chooses method of tunnel construction in accordance with this Specification. Inclusion of various methods in specification or reviews by Project Manager of Contractor's submittals shall not be construed by Contractor as endorsement by Project Manager that all such methods are constructible or will work for specific subsurface soils encountered.

- D. Carrier Pipe is referred to as water line or permanent (secondary) liner. Such water line/permanent liner is defined and installed in accordance with Section 02517 – “Water Line in Tunnels” or Section 02511 – “Water Lines”.
- E. Tunnel Boring Machine (TBM): Mechanized and fully shielded excavating equipment that is steerable, guided and articulated, with man entry.
- F. Shield: Fabricated ground support, circular in section, providing 360 degree protection to those working in it. Shield shall have cutting edge, and be equipped with independently operated hydraulic propulsion rams, allowing it to be steered. Liner is erected within tail attached to shield.
- G. Open Face: Face of heading or tunnel which is unsupported during excavation (e.g., in hand mining or shield excavation).
- H. Closed Face: Face of heading or tunnel which is supported during excavation process from TBM, where cutter head allows both partial exposure of face and full closure, by means of hydraulically operated gates.

1.11 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Primary Tunnel Liner and Supports

- 1. 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. Box tunnels with timber supports will not be allowed. Utilize additional support elements including shotcrete, additional steel sets, breasting, spilling, forepoling, crown bars, soil anchors, or fabrics, as required to provide safe, stable excavation.
- 2. Use 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.

3. Use steel casing as primary liner for tunneling under railroad rights-of-way.
4. Use steel casing as primary liner for tunneling in fault zone crossings and when tunneling under drainage channels, creeks, bayous, and gullies.

B. Material Standards

1. Where use of following materials is required, conform to requirements of following minimum standards:

<u>Material</u>	<u>Reference Standards</u>
Cement	ASTM C150/C150M
Structural Concrete	
Reinforcing Steel Wire	ASTM A82 or A1064/A1064M
Reinforcing Steel Wire Fabric	ASTM A1064/A1064M
Reinforcing Steel Bars	ASTM A615/A615M , Grade 60
Sand and Aggregate	ASTM C33/C33M
Structural Steel	ASTM A36/A36M
Steel Piles, Sheets	ASTM A328
Rings and Ribs	ASTM A36/A36M
Steel Plates	ASTM A36/A36M and A283/A283M
Lumber and Timber	Hardwood, sound or better, as defined by Commercial Standard C560
Steel Casing Pipe	AWWA C200

C. Steel Liner Plates

1. Except as otherwise specified, furnish materials according to applicable requirements of AREMA Manual for Railway Engineering.
2. 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.
3. 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.
4. Use new material for construction of liner plates. Used plates shall not be acceptable.
5. 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. All steel liner plate designs shall meet following minimum factors of safety:

Seam Strength.....	3
Buckling	2
Maximum Deflection	2% (of normal tunnel diameter)

6. Maintain minimum thickness of metal for these steel plates as shown on Plans, allowing for standard mill tolerances.
7. 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 shall 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.
8. Protective coating not required for steel liner plates, unless otherwise specified or shown on Plans.
9. Install gaskets between liner plates when required to control seepage, or as specified or shown in Plans.
10. Steel ribs used with liner plates: Conform to requirements of Paragraph 2.06, Steel Beams and Lagging.

D. Steel Casing Pipe

1. Casing pipe: Provide new uncoated welded steel pipe, manufactured in accordance with AWWA C200. Comply with Section 02518 – “Steel Pipe and Fittings for Large Diameter Water Lines”.
2. Design stress in pipe wall shall be no greater than 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.
3. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.
4. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.
5. Casing pipe design shall also include stresses due to jacking forces when pipe is to be installed by jacking method.

6. 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 9 feet apart.
7. Conform casing pipe used in fault zones to welding and weld testing requirements specified in Section 02518 – “Steel Pipe and Fittings for Large Diameter Water Lines”.
8. 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.

E. Steel Ribs and Lagging

1. Steel ribs and auxiliary structural members shall be free of defects which may impair or reduce their structural integrity. Ribs shall be accurately curved to proper radius of tunnel section (or shaft section) and rib segments shall fit closely for bolted connections at segmental and transverse joints. Provide steel appurtenances required for installation of ribs such as tie rods, bolts, splice plates, dutchmen and drift pins, with ribs.
2. Minimum factors of safety:
 - a. Buckling2
 - b. Stiffness3

F. Timber

1. 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.

G. Filter Fabric

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.

H. Equipment

1. Use only the tunneling method or equipment which shall produce specified results for soils encountered. However, use tunneling method, whether hand or machine, with full-face closure capabilities.
2. Diesel, electrical, hydraulic, or air-powered equipment is 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.

3. When TBM is used, employ equipment that shall be capable of handling various anticipated ground conditions. In addition, TBM shall:
 - a. 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.
 - b. 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.
 - c. 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.
 - d. 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.
 - e. 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.
 - f. Have motors and operating controls protected against water inflow.
 - g. Provide bi-directional drive on cutter head wheel, or fins or grippers to control roll due to rotation.
 - h. 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 Project Manager.
4. When a tunnel shield is used (with or without attached mechanized excavating equipment), employ shield that shall be capable of handling various anticipated ground conditions. In addition, tunnel shield shall:

- a. 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.
 - b. 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.
 - c. 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.
 - d. 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.
 - e. Have motors and operating controls protected against water inflow.
 - f. 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.
5. Air Quality: Provide equipment to adequately ventilate entire tunnel operation during construction, in accordance with OSHA requirements.
- a. 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.
 - b. Provide audible automatic gas alarm on TBM to detect explosive gases. Locate alarm near tunnel face.
 - c. Equip motors and controls with automatic shutoff methane monitoring system.

6. 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.
7. Electrical: Equip electrical systems utilized on TBM with appropriate ground fault system. Electrical systems are to be insulated, not permitting bare-wire exposures.
8. Access: Provide safe access through tunnel to TBM.
 - a. Provide walkway in tunnels greater than 10 feet in diameter which is separate from tracks used by spoil removal equipment.
 - b. Equip locomotives or cars used for transport of personnel with necessary safety devices.
9. Necessary equipment for tunnel excavation includes telephones, signal systems, fire extinguishers, safety equipment, and other equipment required by Contractor's method of construction, work plan, and safety plan. Maintain equipment in good repair, and readily available at place of work.

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S)

- A. Use of various materials and construction methods for tunnel excavation and ground support, such as by tunnel boring machine (TBM), hand tunneling or shield will be allowed provided that proposed products and methods will complete Project in accordance with Specifications, this Section, applicable safety codes, and Project schedules. Contractor responsible for final constructed product, materials and tools used, and for furnishing labor and qualified superintendents necessary for selected method of construction.
- B. Use tunnel liner or casing of a size so that minimum clearance at the bottom between O.D. of carrier pipe and inside of liner is minimum 4 inches, and minimum clearance at the top between O.D. of pipe and inside of liner or casing is in accordance with following:

Carrier Pipe Net I.D.	Minimum Clearance to Top
≥ 48"	9"
42"	7"
36"	5"
≤ 30"	3"

- C. This clearance also applies to distance between carrier pipe and electrical conducting pipe support system.
- D. Furnish all items, such as 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.

3.02 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. Provide stability of face under anticipated conditions.
- 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 pertaining to water line construction within a tunnel area unless otherwise approved by Project Manager.
- G. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA Standards, and Contractor’s Safety Plan.

- H. Perform additional exploration of ground conditions by geotech borings if needed to define necessary parameters for design and for selection of tunneling method. No additional pay.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Tunnel Excavation and Primary Liner Installation

1. Tunnel Excavation:

- a. The selected method of tunnel excavation is subject to review by the Project Manager.
- b. 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.
- c. Limit tunnel excavation to within easements and rights-of-way indicated on Plans, and to lines and grades designated on Plans. Perform excavation of sufficient size to allow installation of water line to lines and grades indicated on Plans.
- d. Locate equipment powered by combustible fuels at suitable distances from shafts to prevent possibility of explosion and fire in shafts or tunnel.
- e. During open-face excavation:
 - 1) 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.
 - 2) 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.
 - 3) 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 Project Manager, fully breast face and shove shield tight against it.
- f. During closed-face excavation:

- 1) Carefully control and monitor volume of spoil removed. For earth-pressure balance TBM, balance spoil removed with advance rate and excavation rate.
 - 2) When cutting face is withdrawn, keep excavated face stabilized as required.
- g. 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. Excavation shall not be advanced beyond the edge of the shield.
2. Size of Tunnel: Determine adequate tunnel size and section to match construction methods described in work plan. Build 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 as shown on Plans or indicated in Specifications. Dimensions shown on Plans do not necessarily represent size or section suitable for construction methods or operational procedures as may be proposed or conducted by Contractor.
3. Primary Liner:
- a. 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.
 - b. 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 nonexpandable liner (e.g., bolted steel liner plates) may be used provided grout is placed behind nonexpandable liner. Grout excavation not to true shape as result of careless excavation or loss of ground.
 - c. 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.
 - d. Expandable liner shall be continuous and shall be expanded to limits of excavation promptly after it is out of shield.
 - e. 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.
- f. 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.
 - g. Provide hog rods, struts, or similar members when required to maintain roundness. After grouting, liner shall be no more than 3 percent out of round as measured by difference between maximum and minimum measured diameter divided by average diameter.
4. Hand Jacking of Casing:
- a. 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.
 - b. 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.
 - c. 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.
 - d. In addition to requirements set for in this specification, Contractor shall:
 - 1) Excavate face commencing at crown and proceed down to invert. Excavate heading so that both sides of heading are excavated simultaneously.

- 2) At all times maintain standby face supports to allow for immediate use when needed.
 - 3) 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.
- e. Distance that excavation extends beyond end of casing pipe shall not exceed three feet. Decrease this distance as directed by Project Manager, or due to character of material being excavated.
 - f. Jack the casing pipe, insofar as practical, from low or downstream end. Lateral or vertical variation in final position of casing pipe from line and grade as established by Project Manager 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.
 - g. 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.
 - h. Remove and replace casing pipe damaged in jacking operations by Contractor at no additional cost to Owner.
 - i. 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 pits remain open without appropriate safety barricades, concrete traffic barriers (CTB's), railing, or plates.
 - j. 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.
5. Grouting:
- a. Detailed requirements pertaining to grout mix design and tunnel grouting are provided in Section 02431 – “Tunnel Grout”.

- b. Furnish and operate suitable equipment for grouting operations to effectively and completely fill voids outside of primary tunnel liner as quickly as possible.
- c. Provide in tunneling work plan description of primary liner grouting operations, including:
 - 1) Arrangement of grouting equipment including mixer, pumps, piping and hoses, valves, pressure gauges and injection fixtures.
 - 2) Location, spacing, and size of grout ports and vents.
 - 3) Grouting sequence for initial backfill of voids between liner and ground, and for second stage back grouting.
 - 4) Grout injection pressures and estimated volumes.
 - 5) Procedure to check for remaining voids.
 - 6) Sampling procedures and locations for quality control testing.
 - 7) Grout production and quality shall be in accordance with Contractor's mix design and grout production plan as required by Section 02431 – "Tunnel Grout".
- d. 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.
- e. 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.
- f. Liner requiring grout shall be back grouted (second stage grouting) once each shift, or more often when required to ensure that all voids are filled.
- g. Place grout behind tunnel liner at end of each day or at every 4 feet of tunnel installed, whichever is less, unless in opinion of Project Manager, 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 Project Manager. After all voids are successfully filled, grout holes shall be packed, when

necessary, with dry mortar mix and threaded taps securely placed in holes.

- h. Completely and immediately fill voids outside limits of tunnel excavation created by caving or collapse of earth cover over excavation, or by other cause, with sand cement grout. Perform second grouting to fill soft spots or voids which may be detected, no later than 24 hours after initial grouting of primary liner.
- i. Perform quality control sampling and testing of grout.
 - 1) Grout production shall be in accordance with Section 02431 – “Tunnel Grout”.
 - 2) Measure density of grout throughout placement procedure as directed by Project Manager. Measure grout density at discharge point and discharge grout until density is within 0.3 pounds per gallon of input density.
 - 3) Take samples of well-mixed grout for 28-day compressive strength tests at beginning, middle, and end of each grouting operation.

B. Tunneling Data

- 1. Submit shift logs of construction events and observations within 24 hours of operation on at least following:
 - a. Location of face by station and progress of tunnel drive during shift.
 - b. Observation of lost ground and other signs of ground movement.
 - c. Location and elevation of significant soil strata boundaries and brief soil descriptions.
 - d. Ground water control operations, piezometric levels, ground water inflow location, and rates.
 - e. Completed field forms for establishing and checking line and grade and achieved tolerance relative to design alignment.
 - f. Operation shut-down periods or other interruptions in Work, and reason.
 - g. Any unusual condition or event.
 - h. Hours worked per shift on tunneling operation.
- 2. Clearly mark primary liner every 20 feet along tunnel with distance in feet from centerline of preceding shaft.

- C. Tunnel Connections, Terminations, and Temporary Bulkheads
1. Connect new tunnels to existing structures by removing existing bulkheads, when necessary, and sealing junction as shown on Plans.
 2. Seal terminations of tunnels, which are not connected to permanent structures, by temporary bulkhead.
 3. Design temporary bulkheads where and when required and obtain Project Manager'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.
- D. Monitoring
1. Monitoring Instrumentation: This specification establishes minimum instrumentation requirements for tunneling. Additional instrumentation requirements for critical areas may be specified elsewhere in Specifications or on Plans. Contractor may install more extensive system at Contractor's sole expense. Instrumentation specified shall be accessible at all times to Project Manager.
 - a. Submit for review, prior to construction, Monitoring Plan including instrument installation design, instrumentation points location and layout, manufacturer's catalog literature, installation report formats.
 - b. 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.
 - c. Installation of instrumentation by Contractor shall not preclude Project Manager, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for independent installations.
 - d. Install soil instruments such as piezometers, inclinometers, extensometers, and crack monitors by qualified subcontractor specializing in geotechnical work.
 - e. Install extensometers to depth of 5 feet above crown of water line tunnel as shown on Plans 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.

2. 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.
3. Settlement Surveying: This specification establishes minimum settlement survey requirements for structures and ground surface monitoring points.
 - a. 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.
 - b. Locate survey points on all structures within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline.
 - c. 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 reestablished when lost or destroyed.
 - d. Unless otherwise specified, record ground surface elevations on center line ahead of TBM and at 20 feet either side of center line at minimum of 100-foot intervals or at least three locations per tunnel drive. Starting 100 feet ahead of TBM and continuing until TBM is 100 feet beyond measurement point or until further movement is not detected, unless otherwise directed by Project Manager. Record cross-sectional points at 10-foot spacing for distance of 50 feet each side of center line or to ROW, whichever is less.
 - e. Locate survey points at crossings under installations as follows:
 - 1) Roads: 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 intersection.
 - f. For shaft settlement see Section 02400 – “Tunnel Shafts”.

4. Measure and maintain records of deformation of primary liner.
5. Reading Schedule and Reporting: Submit readings from various instruments and survey points weekly to Project Manager. Take daily Readings as required by Project Manager when construction is approaching or near critical structures (structures, bridge piers, 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.
 - a. Immediately report to Project Manager movement, cracking, or settlement which is detected and take immediate remedial action. Contractor shall be fully responsible for damage to adjacent structures.
 - b. At end of construction after water line is installed, and dewatering is discontinued, make final survey of control points established for instrumentation and observation. Submit final readings to Project Manager. Make visual inspection of structures adjacent to water line and report to Project Manager condition of structures, damage incurred during construction, and corrective action taken.

E. Disposal of Excess Material

Remove spoil from job site and dispose in accordance with Section 01504 – “Temporary Facilities and Controls”.

3.04 REPAIR/RESTORATION (NOT USED)

3.05 FIELD QUALITY CONTROL

A. Control of Tunnel Line and Grade

1. Construction Control:
 - a. The Project Manager will establish baseline and benchmarks indicated on Plans. Check these baseline and benchmarks at beginning of Work and report errors or discrepancies to Project Manager.
 - b. Use baseline and benchmarks established by Project Manager to furnish and maintain reference lines and grades for construction. Use these lines and grades to establish location of tunnel, water line, and structures.
 - c. 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.

- d. Establish control points sufficiently removed from tunnel operation not to be affected by potential ground movement.
 - e. Maintain daily surveying records of alignment and grade and submit three copies of records to Project Manager by end of day after Work performed. Locate points at top, bottom, and each side of springline.
 - f. 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 Project Manager.
2. Earth Movement: Contractor is responsible for damages due to settlement from construction-induced activities or occurrences.
- a. 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.
 - b. Refer to Paragraph 3.08, Monitoring, for detecting earth movement.
 - c. In event movement of ground is detected, Project Manager may order work stopped and secured. Before proceeding, correct problems causing or resulting from movement.
 - d. Be aware that when settlement of ground surface should occur during construction of tunnel which will affect accuracy of temporary benchmarks established by Project Manager, detect and report movement. Locations of permanent NHCRWA monumentation benchmarks are indicated on Plans; Contractor may use these to verify temporary benchmark accuracy. Advise Project Manager of settlement affecting permanent monumentation benchmarks. Upon completion, submit field books pertaining to monitoring of permanent monumentation benchmarks to Project Manager.
3. Tunnel Line and Grade:
- a. Survey crown, invert, and spring line 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.

- b. 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.
 - c. 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”.
 - d. 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 Project Manager for review.
 - e. Backfill (grout) and reconstruct tunnel built outside tolerance to be within tolerance when so directed by Project Manager.
- B. Ground and Surface Water Control and Ground Stabilization
- 1. Provide necessary ground water and surface water control measures to perform Work and to provide safe working conditions. Detailed plans for ground and surface water control methods shall be executed as designed by the Contractor’s Engineer. 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. Surface water control method shall provide means to control impacts of surface water above or along tunneling operations. Additional requirements are included in Section 01578 – “Control of Ground Water and Surface Water”.
 - 2. 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 determined by Contractor as necessary to achieve stable conditions and applied in manner as described in Section 01578 – “Control of Ground Water and Surface Water”. Standing water is not permitted at face or in tunnel.

3. 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. In event damage does occur, correct damage and settle claims arising from damage at no additional cost.
4. 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 Project Manager. Provide access to piezometers for Project Manager to perform independent measurements.
5. 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.
6. 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.
7. 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 at least down below elevation of invert of tunnel, or to lower elevation as required for excavation face and tunnel stability.

3.06 – 3.10 NOT USED

END OF SECTION

Section 02431

TUNNEL GROUT

PART 1 GENERAL

1.01 SUMMARY

This Section includes:

- A. Mix design requirements, testing, furnishing, and production of grout for:
 - 1. Pressure grouting of bolted liner plates for shafts
 - 2. Pressure grouting of primary tunnel liner
 - 3. Pressure grouting of jacked-pipe
 - 4. Annular grouting of cased or uncased sewer pipe
 - 5. Grouting of annular space between carrier pipe and primary tunnel liner
 - 6. Grouting voids in ground resulting from caving, loss of ground, or settlement
 - 7. Grouting of manholes constructed in shafts
- B. Compaction grouting is not part of this specification.

1.02 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 Work of which it is component part.
 - 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 C 138. Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- B. ASTM C 144. Standard Specification for Aggregate for Masonry Mortar.

- C. ASTM C 150. Standard Specification for Portland Cement.
- D. ASTM C33ASTM C 494. Standard Specification for Chemical Admixture for Concrete.
- E. ASTM C 618. Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- F. ASTM C 869. Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.
- G. ASTM C 937. Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.
- H. ASTM C 942. Standard Test Method for Compressive Strength of Grout for Preplaced-Aggregate Concrete in the Laboratory.
- I. ASTM C33ASTM C 1017. Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 – “Submittal Procedures”.
- B. Submit description of materials, grout mix, equipment, and operational procedures to accomplish each grouting operation. Description shall include sketches as appropriate, indicating type and location of mixing equipment, pumps, gauges, injection points, venting method, flow lines, pressure measurement, volume measurement, grouting sequence, schedule, and stage volumes, as well as procedures to resist movement and counteract floating the carrier pipe during grouting operations. Tests and certifications shall have been performed within last 12 months prior to date of submittal.
- C. Grouting contractor shall provide a project history showing a minimum of 5 years of work and at least 10,000 linear feet of experience in grouting tunnels.
- D. Submit grout mix design report, including:
 - 1. Grout type and designation
 - 2. Grout mix constituents and proportions, including materials by weight and volume
 - 3. Grout densities and viscosities, including wet density at point of placement
 - 4. Initial set time of grout
 - 5. Bleeding, shrinkage/expansion

6. Compressive strength
 7. Detailed description of grout pressure limiting equipment
 8. For annular space grouting, buoyant force calculations and bulkhead designs (See Section 02517 – “Water Line in Tunnel” for further requirements)
- E. For cellular grout, also submit the following:
1. Foam concentrate supplier's certification of product application for foam concentrate.
 2. A description of proposed cellular grout production procedures.
- F. Maintain and submit logs of grouting operations indicating pressure, density, and volume for each grout placement.

1.05 RELATED REQUIREMENTS

- A. Section 01270 – “Measurement and Payment”
- B. Section 01330 – “Submittal Procedures”
- C. Section 02517 – “Water Line in Tunnel”
- D. Section 03315 – “Concrete for Utility Construction”

1.06 – 1.09 NOT USED

1.10 DEFINITIONS

- A. **Pressure Grouting.** Filling void behind liner or pipe with grout under pressure sufficient to ensure void is properly filled but without overstressing temporary or permanent ground support, or causing ground heave to occur.
- B. **Back Grouting.** Secondary pressure grouting to ensure that voids have been filled between primary tunnel or shaft liners and surrounding ground.
- C. **Annular Grouting.** Filling annular space between carrier pipe and primary tunnel liner, casing, or ground, by pumping.
- D. **Ground Stabilization Grouting.** Filling of voids, fissures, or under-slab settlement due to caving or loss of ground by injecting grout under gravity or pressure to fill void.
- E. **Carrier Pipe.** Sewer or water line installed inside primary tunnel support.

1.11 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

- A. Grouting materials: Conform to Section 03315 – “Concrete for Utility Construction”, except as modified in the following paragraphs.
- B. Grout Type Applications:
 - 1. Grout for pressure grouting, backfill grouting, and annular grouting: Sand-cement mortar mix.
 - 2. Alternative grout for annular grouting of water line: Low density (cellular) grout.
 - 3. Grout for annular grouting of sanitary sewer: Low density (cellular) grout, unless otherwise approved by Project Manager.
 - 4. Grout for filling space around manholes in shafts: Sand-cement mortar mix.
 - 5. Ground stabilization: Sand-cement mortar mix.
- C. Do not include toxic or poisonous substances in grout mix or otherwise inject such substances underground.
- D. Grout
 - 1. Develop one or more mixes based on following criteria as applicable and provide test reports from a professional laboratory for each mix design:
 - a. Size of annular void between carrier pipe and liner, or size of void between primary liner and surrounding soil
 - b. Absence or presence of groundwater
 - c. Adequate retardation
 - d. Non-shrink characteristics
 - e. Pumping distances
 - 2. Prepare mixes that satisfy required application. Provide materials conforming to the following standards:
 - a. Cement: ASTM C 150

- b. Fly Ash: ASTM C 618. Do not use fly ash in amounts to exceed 25 percent by weight of cementitious material in mix design.”
 - c. Water: Potable
 - d. Foam: ASTM C 869. The foaming agent shall maintain stability until the cement sets to form a self-supporting matrix comprising closed cells and low water absorptive characteristics.
 - e. Slurry: ASTM C 138
 - f. Cellular Grout: ASTM C 138
 - g. Sand for sand-cement mortar mix: ASTM C 144
 - h. Retarder/water reducer: ASTM C494, Type D
 - i. Plasticizer/water reducer: ASTM C494, Type A
 - j. Fine aggregate: ASTM C33
3. Provide grout meeting the following minimum requirements:
- a. Low Density Cellular Grout
 - 1) Cement content shall be no less than 200 lb/cubic yard.
 - 2) Water content shall be no more than 65 percent.
 - 3) Wet density shall be no less than 65 lb/cubic foot.
 - 4) Minimum compressive strength shall be 100 psi after 7 days and 300 psi after 28 days.
 - b. Conventional (Mortar) Grout
 - 1) Conventional grout shall consist of a pumpable mix of 1-part cement, 2-part clean sand, water free from organics and deleterious materials, and a small amount of bentonite for pumpability and stability. The unit weight shall not be less than 130 lb/cubic foot.
 - 2) Minimum 28-day unconfined compressive strength shall be 1,500 psi for water lines and 1,000 psi for other carrier pipes.
 - 3) Determine strength by ASTM C942.

4. Fluidifier. Provide fluidifier, meeting ASTM C 937 that holds solid constituents of grout in colloidal suspension and is compatible with cement and water used in grouting operations.
5. Admixtures.
 - a. Use admixtures meeting ASTM C 494 and ASTM C 1017 as required, to improve pumpability, control time of set, hold sand in suspension and reduce segregation and bleeding.
 - b. For cellular grout, do not use foam or admixtures that promote steel corrosion
 - c. Ensure that admixtures used in mix are compatible. Provide written confirmation from admixture manufacturers of their compatibility.
 - d. Admixtures shall not contain chlorides, and shall be non-toxic after 30 days.
 - e. Amount of admixture added to concrete shall be in accordance with the manufacturer's recommendations.

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

3.02 PREPARATION

- A. Notify Project Manager at least 24 hours in advance of grouting operations.
- B. Select and operate grouting equipment to avoid damage to new or existing underground utilities and structures.
- C. In selection of grouting placement consider pipe flotation, length of pipe, length of tunnel, depth from surface, type of pipe, type of pipe blocking and bulkheading, grout volume and length of pipe to be grouted between bulkheads.
- D. Operate dewatering systems until grouting operations are complete and grout has reached initial set.
- E. Verify that locations where grout is to be placed are clean and free of standing or running water.
- F. A bulkhead designed by the Contractor shall be placed in the annular space at each end of tunnel section that is to be grouted. Provide an opening in the crown in addition to other required vent outlets. Provide an opening for the tunnel invert drain and at the

casing invert to facilitate draining water away from the Work during grouting operations.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Equipment

1. Batch and mix grout in equipment of sufficient size and capacity to provide necessary quality and quantity of grout for each placement stage.
2. Use equipment for grouting of type and size generally used for work, capable of mixing grout to homogeneous consistency, and providing means of accurately measuring grout component quantities and accurately measuring pumping pressures. Use pressure grout equipment which delivers grout to injection point at steady pressure.
3. Foam Generator for Cellular Grout: Foam shall be generated by combining controlled quantities of air, water, and foaming agent under pressure in accordance with the foaming agent manufacturer's recommendations. The temperature of water used in generating the foam shall be maintained below 80°F, or as recommended by the foaming agent manufacturer. Foam shall be discharged into the mixer and blended with the cement slurry.
4. Mixing: The mixer shall be configured for compatibility with the pump to ensure continuous and uniform flow at the point of placement. The mixer shall be capable of providing a super-wetted, homogenized mix. The mixer shall be fitted with a meter with an accuracy of ± 1 gallon to measure the volume of water added to dry mix ingredients. An automated system shall be provided capable of delivering a neat cement grout to the mixer and pump in the tunnel where grouting is to be performed.
5. Pumping: Pumping equipment shall be capable of pumping concrete without pulsation or segregation. Pumping equipment shall be operated to convey a continuous and uniform stream of concrete without air pockets. Pumping equipment shall be equipped with a water connection for flushing the system and a device to limit pumping pressure as required to prevent damage to pipe.
6. Agitator: A separate agitator shall be provided to serve as a holding tank between the mixer and the pump. The agitator shall be equipped with baffles to induce turbulence and rotating paddles to ensure thorough mixing of the grout before and during injection.
7. Piping, Injection Hoses, Ports, Valves and Connections: Concrete shall be conveyed to placement points using piping or rubber hoses, with all components having an internal diameter of at least 2 inches. Do not allow hardened grout or concrete to obstruct or coat pipe or hose internally. A system of valves shall be furnished in the line at or near the points of injection

to facilitate sample collection. Suitable stop valves shall be furnished at injection points for use in venting air or maintaining pressure, as required.

8. Provide certified oil-filled gauges scaled to not more than 150% of the maximum allowable pressure, accurate to within 0.5% over the full range of the gauge. Pressure gauges shall be certified and calibrated in accordance with ASME B40.1, Grade 2A. Pressure gauges shall be oil-filled type gauges attached to a saddle-type diaphragm seal (gauge saver) to prevent clogging with grout.

B. Pressure Grouting for Primary Tunnel and Shaft Liner

1. Perform grouting operations to fill voids outside of primary tunnel or shaft liner.
2. For nonexpendable primary liners installed behind shield or tunnel boring machine (TBM), fill voids with sand-cement grout promptly after each ring of liner is out of shield. Keep grout pressure below value that may cause damage or distortion to installed liner plate rings. Provide seals on tail of shield or TBM which shall prevent grout from spilling.
3. For nonexpendable primary liners installed by hand mining or in shafts, grout once every 4 feet but no later than the end of each, or more frequently when conditions dictate. Upon completion of each grouting operation, sound tunnel liner and immediately correct voids discovered by necessary means.
4. Use care in grouting operations to prevent damage to adjacent utilities or other properties. Keep grout pressure below value that may cause damage or distortion to installed tunnel liner or shaft liner. Control grout pressures so that tunnel or shaft liner is not overstressed, and ground heave is avoided.
5. For liner requiring grout, perform back grouting once each shift, or more often when required to ensure that all voids are filled.
6. Grout shall only be pumped to one hole at a time.
7. Grouting shall be performed in a progressive, methodical manner, moving from hole to hole, starting at one end of the tunnel and working to the other end. Grouting shall be from lower holes to higher holes as the case may be.
8. To the extent possible, air and groundwater shall be relieved through valved, open, and ungrouted holes downstream of the hole being grouted. Valved, open, and ungrouted holes shall not be closed until grout of the same consistency as that being injected issues forth.
9. Contractor shall remove grout valves and shall cap the grout ports after grout has reached initial set.

- C. Annular Grouting for Water and Sewer Line in Tunnels and Augers
1. Methods employed shall completely fill the annular space between tunnel liner and carrier pipe with grout.
 2. Placement
 - a. 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 continue at grout port longer than that period of time for mix to take initial set. Locate grout hole spacing and locations according to number of stages necessary to grout tunnel liners. Stage or lift cannot be installed on another lift until proper set has been attained. Have placement procedures approved by admixture or additive manufacturer.
 - b. Limit pressure on annular space to prevent damage or distortion to pipe or liner. Define limiting and estimated required pressure range. Provide an open ended, high point tap or equivalent vent and monitor it at bulkhead opposite to point of grouting.
 - c. 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.
 - d. For sewer line in primary lined tunnel, limit length of pipe installed to 200 feet or less before grouting same length of sewer line. Repeat this cycle until all pipe is installed and grouted.
 - e. Use methods as required to avoid pipe flotation and damage to pipe. Complete each lift for a particular section of tunnel being grouted before starting the next lift. Lift heights shall be limited to avoid pipe flotation and to maintain cellular grout parameters within specified limits. There shall be no fewer than 2 lifts per annular grouting operation.
 3. Remove temporary bulkheads installed for grouting.
 4. Batch and mix cellular grout mechanically with a colloidal mixer at the project site to ensure consistency of mix. Wet solids thoroughly before introduction of foaming agent. Operate batching system to maintain slurry density with the requirements of Paragraph 3.05.B.3. Shear foam into slurry in accordance with manufacturer's recommendations.
 5. Control ground water as necessary to permit completion of grouting without separation of grout materials.

D. Pressure Grouting for Jacked Sewer Pipe

1. For jacked pipe 60 inches in diameter or greater, pressure grout annulus after installation, displacing bentonite lubrication. Jacked pipes less than 60-inch diameter may be left ungrouted unless excavated diameter exceeds external pipe diameter by more than one inch.
2. Inject grout through grout holes in sewer pipe. Drilling holes from surface or through carrier pipe walls is not allowed. Perform grouting by injecting it at pipe invert with bentonite displacement occurring through high point tap or vent.
3. Control ground water as necessary to permit completion of grouting without separation of grout materials.
4. Limit pressures to prevent damage or distortion to pipe or to keep flexible pipe within acceptable tolerances.
5. Pump grout until material discharging is similar in consistency to that at point of injection.

E. Ground Stabilization Grouting

1. Completely fill voids outside limits of excavation caused by caving or collapse of ground with sand-cement grout. Perform second grouting to fill soft spots or voids which may be detected, no later than 24 hours after initial grouting of tunnel liner.
2. Take care in grouting operations to prevent damage to adjacent utilities or public or private property. Grout at pressure that shall not distort or imperil portion of Work or existing installations or structures.
3. Verify that void has been filled by volumetric comparisons and visual inspection. In case of settlement under existing slabs, take cores as directed by Project Manager, at no additional cost, to demonstrate that void has been filled.

3.04 REPAIR/RESTORATION (NOT USED)

3.05 FIELD QUALITY CONTROL

A. Pressure Grouting for Primary Tunnel and Shaft Liners.

1. For each shaft, make one set of four compressive test specimens for each 30-foot depth and one set for remaining portion less than 30-foot increment.
2. Make one set of four compressive test specimens for every 200 feet of primary lined, (non-expandable) tunnel requiring grout.

- B. Annular Grouting for Water and Sewer Line in Tunnels and Augers.
1. Make one set of four compressive test specimens for every 200 feet of pipe installed in primary lined tunnel.
 2. For augers, make one set of four compressive test specimens for each grouting operation, or for each 100 feet of pipe installed, whichever is more frequent.
 3. For cellular grout, check slurry density both at point of batching and placement at least twice each hour in accordance with ASTM C 138. Record density, time, and temperature. Density must be within 3 percent of design density at point of batching and 5 percent of design density at point of placement.
 4. Measure and record the volume of grout placed. Compare actual volume placed for each length of tunnel being grouted with the theoretical volume for that length of tunnel being grouted. Collect samples of fresh cellular grout at the injection point or discharge point.
 5. Wet Density Test for Cellular Grout: Sample at the injection point every 30 minutes, after a change in the mix batched, and whenever compression test cylinders are made.
 6. Compression Tests: Take two sets of two cylinders for every 200 cubic yard batched, but no less than two sets per day, two sets per annulus between carrier pipe and tunnel liner grouted, or two sets per lift. Test two cylinders at 28 days and test the additional two cylinders at 56 days, if fly ash is used. For testing, cylinders shall be capped with plaster of Paris; sulfur caps are not permitted.
- C. Pressure Grouting for Jacked Pipe. Make one set of four compressive test specimens for every 400 feet of jacked pipe pressure grouting.
- D. Ground Stabilization Grouting. Make one set of four compressive test specimens for every location where ground stabilization grouting is performed.

3.06 – 3.10 NOT USED

END OF SECTION

Section 02441

MICROTUNNELING AND PIPE-JACKED TUNNELS

PART 1 GENERAL

1.01 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 centrifugally-cast fiberglass pipe (FRP), vitrified clay pipe (VCP), reinforced concrete pipe (RCP) for storm or sanitary 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.

1.02 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 Project Manager 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.

1.03 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).

1.04 DEFINITION

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.

1.05 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 Project Manager 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 postconstruction 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 Project Manager.
8. Daily Reports: Maintain shift log as defined in Paragraph 3.04, Pipe-jacked Tunneling Data, and make available to Project Manager on request.

1.06 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 HS-20 vehicle loading distributions in accordance with AASHTO.
- 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 Project Manager that design flows and velocities can be achieved.

PART 2 PRODUCTS

2.01 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. Centrifugally-cast fiberglass pipe, joints, and fittings to be in accordance with Section 02504 - Centrifugally-Cast Fiberglass 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.

PART 3 EXECUTION

3.01 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.

3.02 GROUND WATER CONTROL

Provide ground water control measures in conformance with Section 01578 - Control of Ground Water and Surface Water, when necessary to perform Work.

3.03 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.

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.

3.04 PIPE-JACKED TUNNELING DATA

Maintain shift logs of construction events and observations. Project Manager 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 is halted.

3.05 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 Project Manager. 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.

3.06 CONTROL OF LINE AND GRADE

A. Construction Control.

1. Project Manager will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report any errors or discrepancies to Project Manager.
2. Use baselines and benchmarks established by Project Manager 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. Locations of permanent monumentation benchmarks are indicated on Drawings. Advise Project Manager of any settlement affecting permanent monumentation benchmarks.

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 1½ inches in elevation from theoretical.
5. Pipe installed outside tolerances and subsequently abandoned shall first be fully grouted.

3.07 MONITORING

- A. Instrumentation Monitoring. Instrumentation requirements are shown on Drawings. Instrumentation specified shall be accessible at all times to Project Manager. Readings shall be submitted promptly to Project Manager.
 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 Project Manager, 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 Project Manager, 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), and

c. When zone of active excavation has passed and no further movement is detected.

3. All monitoring readings shall be submitted promptly to Project Manager.

4. Immediately report to Project Manager any movement, cracking, or settlement which is detected.

5. Following substantial completion but prior to final completion, make final survey of all monitoring points.

3.08 DISPOSAL OF EXCESS MATERIAL

Remove spoil in accordance with Section 01576 - Waste Material Disposal.

3.09 ACCEPTANCE TESTING

Acceptance testing is to be carried out by methods described in Section 02533 - Acceptance Testing for Sanitary Sewer.

END OF SECTION

Section 02447

DRY AND SLURRY AUGERING OF PIPE AND CONDUIT

PART 1 GENERAL

1.01 SUMMARY

This 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 Program Manager, 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 REFERENCES

- 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 Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.04 RELATED REQUIREMENTS

- A. Section 01270 – “Measurement and Payment”
- B. Section 01330 – “Submittal Procedures”

- C. Section 01555 – “Traffic Control and Regulation”
- D. Section 01576 – “Waste Material Disposal”
- E. Section 01578 – “Control of Ground Water and Surface Water”
- F. Section 02233 – “Clearing and Grubbing”
- G. Section 02260 – “Trench Safety Systems”
- H. Section 02317 – “Excavation and Backfill for Utilities”
- I. Section 02425 – “Tunnel Excavation and Primary Liner”
- J. Section 02431 – “Tunnel Grout”
- K. Section 02502 – “Steel Pipe and Fittings”
- L. Section 02511 – “Water Lines”
- M. Section 02517 – “Waterline in Tunnels”
- N. Regulatory Requirements
 - 1. Conform to TxDOT requirements for installations under State Highways. Engineer will obtain required permits for State Highway crossings.
 - 2. Installations Under Railroads:
 - a. 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.
 - b. Use auger method only.
 - c. 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.
 - d. Maintain equipment and excavations minimum 35-foot clearance from centerline of tracks.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 – “Submittal Procedures”.
- B. Submit product data for casings, insulators / casing spacers, spacing of insulators / casing spacers for specific pipe and location on project.

- C. Prior to installation of pits, submit for Program Manager's approval, pit locations, size, depth, and areas for storage, material, and spoil handling. Acceptance of Project Manager 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 Program Manager.
- F. Provide cutting head size to be used in conjunction with slurry augers.

1.06 – 1.09 NOT USED

1.10 DEFINITIONS

- A. Auger Methods:
 - 1. Dry 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.
 - 2. Slurry Auger Method: Installation of steel casing or carrier pipe by first drilling small diameter pilot hole from pit to pit, followed by removing excess soil and installing casing or pipe by pull-back or jacking method.
 - 3. Annular Space: space between carrier pipe and primary tunnel liner, casing, or ground.

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

- A. Criteria for Selection of Material

Contractor shall be responsible for selection of casing, pipe, and pipe joints to carry anticipated thrust of jacks or loads.
- B. Piping and Fittings: As required by Specification or Plans.
- C. Casings: Provide steel casing in accordance with Section 02502 – “Steel Pipe and Fittings”. The size of casing shall be based on the minimum clearance between the carrier pipe and the casing as defined in Section 02425 – “Tunnel Excavation and Primary Liner”, Paragraph 2.01.B. Additionally, the sizing of casings shall exceed the O.D. of any external joint restraints. Provide casing with smooth, continuous interior surface.

- D. Casing Spacer Dimensional Requirements: Provide casing spacer width 8 inches for pipe sizes up to and including 12 inches; 12 inches for pipe sizes larger than 12 inches. Wood skids or concrete “donuts” are not acceptable. Maximum pipe diameter for use of spacers is 30 inches. Additionally, the sizing of casing spacers shall exceed the O.D. of any external joint restraints.
1. For pipe materials 12 inches and smaller, use Advance Products & Systems, Inc. Model SI8-2, Pipeline Seal & Insulator Model C8G-2 or approved equal.
 2. For pipe materials above 12 inches, use Advance Products & Systems, Inc. Model SI12-2, Pipeline Seal & Insulator Model C12G-2 or approved equal.
- E. Casing Spacer Material Requirements: 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: 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 water-tight 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.
- F. Casing End Seals: Provide Advance Products & Systems, Inc. Model AC, Pipeline Seal and Insulator Model C, or approved equal.
- G. Annular Grout:
1. Material: Low density (cellular) grout or sand-cement mortar mix.
 2. Provide annular grout in accordance with Section 02431 – “Tunnel Grout”.

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

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 Plans, in accordance with this Section.
- D. Install temporary solid plug at open end of water line to prevent contamination.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Limits on Auger Length Without Steel

- 1. Do not exceed the lengths for auger holes in Table 1 when augering without steel casing between pits. See Paragraph 3.03.A.2 for restrictions.

Table 1
 Acceptable Lengths for Auger Holes Without Steel Casing

Pipe Diameter	Max Length (LF)
Less than or equal to 8-inches	125
12-inches	100
16 to 20-inches	80
24 to 30-inches	60

- 2. If groundwater is encountered in the auger hole and the dewatering system is not able to dry up the subsurface to provide stable conditions, the lengths above should be reduced based on the field conditions as agreed to by the Project Manager. Reduced auger hole lengths shall be at least 25% of the above listed maximum length.

B. Traffic Control

- 1. Conform to applicable provisions of Section 01555 – “Traffic Control and Regulation”.
- 2. Secure right-of-entry for crossing Railroad Company's easement or right-of-way.
- 3. 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.

C. Pits

1. 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, or culverts, or near potentially contaminated areas.
2. Pit Size: Size pits to provide adequate room to meet operational requirements for auger construction as well as structures indicated on Plans. Provide minimum 6-inch space between casing or pipe and walls of bore pit. Maximum allowable width of pit shall be no greater than 5 feet outside of the casing or pipe. Width of pit at surface shall not be less than at bottom.
3. Excavate bore pits to a finished grade of at least 6 inches lower than grade indicated by stakes.
4. Backfill in accordance with Section 02317 – “Excavation and Backfill for Utilities”.
5. 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”.
6. Provide and properly maintain safety protection against traffic, and accidental or unauthorized entry. Provisions shall include concrete traffic barriers or other suitable barrier around periphery of pit as appropriate.
7. Fully cover and secure pits with steel plates where no construction activity is in progress.
8. Install sheeting, lining, shoring, and bracing required for protection of workmen and public in accordance with Section 02260 – “Trench Safety Systems”.
9. 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 Ground Water and Surface Water”.

D. Slurry Augering

1. Auger from approved pit locations. Excavate for pits and install shoring as outlined above under Paragraph 3.03.C, Pits. Auger mechanically with use of 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.

2. 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.
3. 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.
4. Cover the open end of pipe before inserting into the auger hole.
5. Allowable variation from line and grade shall be as specified under Paragraph 3.03.G, Jacking.
6. Remove and replace pipe damaged in augering operations.

E. Dry Augering of Steel Casing

1. 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.
2. 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.
3. 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.
4. The annular space of dry augers shall be grouted when necessary in accordance with Sections 02431 – “Tunnel Grout” and 02517 – “Waterline in Tunnels”.

F. Filling Annular Space When Using Slurry Auger Method

1. For pipe diameters up to 16 inches, 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 ½-cubic-foot clay; for pipe diameters 12 inches through 16 inches use minimum ¾-cubic-foot clay.
2. When diameter of auger hole exceeds diameter of bell by more than 2-inches, grout the annular space between the pipe and the excavated hole.

3. For pipe diameter greater than or equal to 20 inches, grout the annular space between pipe and excavated hole.
4. Refer to the Material Applications for Tunnel & Auger Construction table under Paragraph 3.03.K.

G. Jacking

1. Comply with Section 02260 – “Trench Safety Systems” for all pits, end trenches, and other excavations relating to Work required by specifications. Dewater as required to provide safe working conditions.
2. Wherever end trenches are cut into sides of embankment or beyond it, sheath securely and brace such work to prevent earth caving.
3. Make up only one joint at time in pit or trench prior to jacking.
4. Do not interfere with operation of railroad, street, highway, or other facility, nor to weaken or damage embankment or structure.
5. 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.
6. 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.
7. Excavation may extend beyond end of casing depending on character of material, but shall not exceed 2 feet. Decrease advance excavation at direction of Program Manager, when character of material being excavated makes it desirable to keep advance excavation closer to end of casing.
8. Jack casing from low or downstream end. Lateral or vertical variation in final position of casing from line and grade as shown on Plans 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 Plans.

Section 02517

WATER LINE IN TUNNELS

PART 1 GENERAL

1.01 SUMMARY

This Section includes 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.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made under this section. Include payment in Unit Price for Section 02511 – “Water Lines”.
2. Payment for installation of water line constructed according to Section 02425 – “Tunnel Excavation and Primary Liner” will be authorized by Project Manager 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.

1.03 REFERENCES

ASME B40.100 - Pressure Gauge and Gauge Attachments.

1.04 SUBMITTALS

A. Submit work plan including following information in accordance with Section 01330 – “Submittal Procedures”.

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 3.03.E, Tunnel Survey.
- C. Submit results of installed water line survey in accordance with Paragraph 3.03.M, As-built Survey and Installation Tolerances.

1.05 RELATED REQUIREMENTS

- A. Section 01270 – “Measurement and Payment”
- B. Section 01330 – “Submittal Procedures”
- C. Section 02425 – “Tunnel Excavation and Primary Liner”
- D. Section 02431 – “Tunnel Grout”
- E. Section 02447 – “Dry and Slurry Augering of Pipe and Conduit”
- F. Section 02511 – “Water Lines”
- G. Section 03315 – “Concrete for Utility Construction”

1.06 QUALITY ASSURANCE (NOT USED)

1.07 SYSTEM DESCRIPTION

- A. Procedures
 1. Joints: Prepare joints as recommended by pipe manufacturer and in accordance with Section 02511 – “Water Lines”.
 2. 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.
 3. Grouting: Perform grouting of annular space between water line and tunnel liner to fill voids with grout, without dislocating or damaging pipe.

1.08 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Annular Grout

Specified in Section 02431 – “Tunnel Grout”

B. Concrete

Meeting requirement of Section 03315 – “Concrete for Utility Construction”, Class B concrete.

C. Pipe Material and Fittings

Manufacture and deliver pipe material and fittings as described in Section 02511 – “Water Lines”.

D. Spacers

Unless otherwise noted on Plans, use casing spacers between water line and casing tunnel liner for water lines less than 36 inches in diameter. See Section 02447 – “Dry and Slurry Augering of Pipe and Conduit” for spacer requirements and installation.

PART 3 EXECUTION

3.01 – 3.02 NOT USED

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Grout in place tunnels for water lines with diameters of 36 inches or greater.

B. When tunnel liner plate is used, grout water line in place regardless of water line diameter.

C. Grout water lines in accordance with Section 02447 – “Dry and Slurry Augering of Pipe and Conduit”, Paragraph 3.03.K Material Applications for Tunnel & Auger Construction.

D. Tunnel Survey

Prior to installing water line in tunnel: Perform survey of tunnel in accordance with Paragraph 3.03.M.2. 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 Project Manager of proposed correction method. Project Manager will make final decision on acceptability of correction.

E. Pipe Transport in Tunnel

Transport pipe in tunnel for final placement so that no damage occurs to pipe ends or pipe barrel and interior lining or exterior coating due to contact with primary liner or point loading from pipe blocking system. Repair pipe damaged during transport or final placement in tunnel in manner acceptable to Project Manager prior to joining. Remove damaged pipe from tunnel and replace, when directed by Project Manager, at no additional cost.

F. Tunnel Cleanup

1. 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.
2. 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.

G. Invert Pipe Support

Construct invert pipe support of screeded concrete 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 primary liner.

H. Joining Pipe in Tunnels

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.

I. Blocking Pipe in Tunnel and Bulkheads

1. Develop and submit pipe blocking system that shall 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.

2. Prevent pipe from floating during backfill operations by properly installed blocking. Remove and replace segment of pipe which is distorted or moved from final line and grade.
3. Secure blocking in place so that it cannot be dislodged during adjacent pipe laying and during grouting operations.
4. 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 Project Manager. Provide adequate venting for bulkheads.

J. Annular Grout

1. Fill annular void between water line and tunnel primary liner or casing with grout, in accordance with Section 02431 – “Tunnel Grout”.
2. Delay grouting until all significant differential movement has stopped as determined by monitoring.
3. 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.
4. Placement:
 - a. 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.
 - b. Equipment - Pumps: Pumping equipment must be of sufficient size and capacity to place grout to distances, velocities 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 Project Manager. Pumping test and verification testing of resulting grout quality shall be required for approval.
- c. 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.
 - d. Grout Connections: Grout connections shall be sized minimum of 2-inch inside diameter, consisting of grout hose attached immediately to pressure gauge. Ensure gauges are in proper working order prior to commencing grouting operations. Gauged pumping pressure shall not exceed water line manufacturer's recommendations. Monitor grout pressure.
 - e. Gauges:
 - 1) Type: Instrument oil-filled and attached to saddle-type diaphragm seal (gauge saver) to prevent clogging with grout.
 - 2) Calibration: Certified and calibrated in accordance with ASME B40.1.
 - 3) Range: Provide gauge with 100 percent greater than pipe manufacturer's design collapse pressure.
 - 4) Accuracy: No more than one-half percent error over full range of gauge.
 - 5) Fitting: Attach gauge to valve immediately attached to grout port in tunnel liner. Provide T-fitting in injection line for sampling.
 - f. 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.
 - g. 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.
 - h. Drilling of access holes from surface to facilitate grouting shall not be allowed.

- i. 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.
 - j. The headerman at point of placement shall advise batch plant of variations of density and make corrections as necessary. Record and submit to Project Manager for each days pour variations and corrections.
- 5. Remove bulkheads unless constructed of masonry.
 - 6. Repair or replace damage or distortion to water line.
- K. Grouting Joints
- Materials and procedures for filling interior joint recesses shall conform to Section 02511 – “Water Lines”.
- L. As-Built Survey and Installation Tolerances
- 1. Perform as-built survey on installed water line. Determine horizontal and vertical location for invert of each pipe joint.
 - 2. Acceptable tolerances: Within plus or minus 3 inches of horizontal alignment, within plus or minus 2 inches of vertical alignment.
 - 3. Correct pipe section outside acceptable tolerances.

3.04 – 3.06 NOT USED

3.07 CLEANING

Clean interior of pipe after interior work is completed. Remove loose material, dirt, and debris from completed pipeline. Maintain the condition of the pipe free of dirt, water, and other debris after the completion of Work inside the pipe for the internal inspection and until the time that the pipe is ready to be filled for testing and placing in service.

3.08 – 3.10 NOT USED

END OF SECTION