E-4 SANITARY SEWER PROJECT
Solicitation Number: CO-00376
Job No.: 19-1548

ADDENDUM 1

December 8, 2020

To Respondent of Record:

This addendum, applicable to project referenced above, is an amendment to the proposal, plans and specifications and as such will be a part of and included in the Contract Documents. Acknowledge receipt of this addendum by entering the addendum number and issue date on the space provided in submitted copies of the Respondent Questionnaire.

CHANGES TO THE SPECIFICATIONS

1. Insert "Electronic Proposal Opening Instructions" after the Request for Competitive Sealed Proposal.
2. Remove existing "Supplementary Instructions to Respondents" section in its entirety and replace with "Supplementary Instructions to Respondents" attached to this Addendum No. 1. This section has been replaced to correct the point value assigned to Team Qualifications and Experience in "Section E: Response Format".
3. Insert Specification SS 853 – Glass-Fiber Reinforced Polyester (FRP) Manholes.
4. Insert Specification SS 1050 – Survey Controls.
5. Insert Specification SS 2140 – Control of Ground and Surface Water.
6. Insert Specification SS 2218 – Low Density Cellular Grout Fill.
7. Insert Specification SS 2242 – Water Control for Shaft Tunnel Construction.
8. Insert Specification SS 2314 – Tunneling with Steel Liner Plate.
9. Insert Specification SS 2315 – Portal Stabilization.
10. Insert Specification SS 2400 – Tunnel Shafts.
11. Insert Specification SS 2426 – Carrier Pipe in Tunnels.
12. Insert Specification SS 2441 – Pipe-Jacked Tunnels.
13. Insert Specification SS 2442– Direct Pipejacking Tunnels.
14. Insert Specification SS 2445 – Settlement Monitoring.
15. Insert Specification SS 2610 – Steel Casing Pipe.
16. Insert Specification SS 3360 – Contact Grouting.

CHANGES TO THE PLANS

- N/A

CLARIFICATIONS

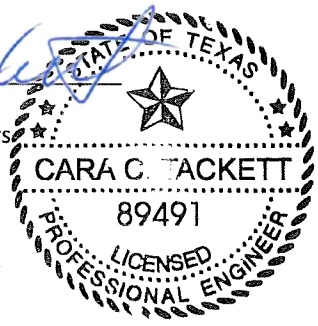
- N/A

END OF ADDENDUM

This Addendum, including these two (2) pages, is one hundred and twenty (120) pages with attachments in its entirety.

Attachments:
Electronic Proposal Opening Instructions (1 page)
Supplementary Instructions to Respondents (13 pages)
Specification SS 853 – Glass-Fiber Reinforced (FRP) Manholes (3 pages)
Specification SS 1050 – Survey Controls (4 pages)
Specification SS 2140 – Control of Ground and Surface Water (11 pages)
Specification SS 2218 – Low Density Cellular Grout Fill (5 pages)
Specification SS 2242 – Water Control for Shaft Tunnel Construction (4 pages)
Specification SS 2314 – Tunneling with Steel Liner Plate (20 pages)
Specification SS 2315 – Portal Stabilization (5 pages)
Specification SS 2400 – Tunnel Shafts (8 pages)
Specification SS 2426 – Carrier Pipe in Tunnels (4 pages)
Specification SS 2441 – Pipe-Jacked Tunnels (12 pages)
Specification SS 2442 – Direct Pipejacking Tunnels (11 pages)
Specification SS 2445 – Settlement Monitoring (6 pages)
Specification SS 2610 – Steel Casing Pipe (4 pages)
Specification SS 3360 – Contact Grouting (6 pages)

Cara C. Tackett, P.E.
Pape-Dawson Engineers



E-4 SANITARY SEWER
Solicitation Number: CO-00376

ELECTRONIC PROPOSAL OPENING INSRUCTIONS
January 8, 2021 AT 2:00 PM (CDT)

FTP PROPOSAL UPLOAD

In order to receive **electronic proposals** for this RFCSP, SAWS will utilize a SAWS secured File Transfer Protocol (FTP) site. Only Respondents submitting as Prime Contractors will need to submit their request prior to **January 7, 2021 by 2:00 pm (CDT)** to receive access to the FTP site via email to **roxanne.lockhart@saws.org**. Respondent's email shall provide the legal name of the Respondent's company and the intended recipient's email address and phone number. No requests for FTP site access will be accepted after **January 7, 2021 by 2:00 pm (CDT).** Once a Respondent is approved for access, an email with a hyperlink to the FTP site and a unique password for the Respondent will be provided to the Respondent's email recipient.

Once access is received, Respondents may upload the required documents per the revised Respondent's Proposal Checklist any time before **January 8, 2021 at 2:00 PM (CDT). Please ensure to allow sufficient time should Respondents experience technical difficulties in uploading the required documents. No changes to the proposal price can be made once the proposal has been submitted.**

Respondents shall comply with the following:

1) Limit files to three (3) pdf files that includes all items as indicated on the revised Respondent's Proposal Checklist. ONLY 3 SUBMITTALS PER RESPONDENT WILL BE ACCEPTED PER REQUEST. Do not upload zip files.
2) Ensure that the itemized General Price Proposal Items is the first page(s) of File 1.
3) Respondents may protect the documents from editing by adding a password. **However, the document must be accessible for viewing by SAWS without requiring a password.**
4) Files shall be titled as required on the Respondent's Proposal Checklist.
5) DO NOT SHARE ACCESS AND/OR PASSWORD WITH OTHER PARTIES OUTSIDE YOUR COMPANY.
6) ENSURE THE PROPOSAL IS SENT NO LATER THAN THE DUE DATE AND TIME. PROPOSALS SUBMITTED AFTER THE PROPOSAL OPENING DEADLINE WILL NOT BE ACCEPTED.

If Respondent is in need of help, they may contact the SAWS Contract Administrator, **Roxanne Lockhart**, at **210-233-3095** or view troubleshooting tips at http://www.Serv-U.com/sharefiles

WEBEX PROPOSAL OPENING MEETING

WebEx meeting details are below, if Respondent would like to view the public opening of the price proposals.

When it's time, start or join the WebEx meeting from here.

Access Information
Meeting Number: **146 050 9782**
Meeting Password: mPfFRQ4mn36
Audio Connection: +1-469-210-7159 United States Toll (Dallas)
+1-408-418-9388 United States Toll

If Respondent has questions or concerns, please contact Roxanne Lockhart.

Roxanne Lockhart
Contract Administrator
2800 U.S. Highway 281 North, Ste. 171 | San Antonio, TX 78212
Office | 210-233-3095
Email | **roxanne.lockhart@saws.org**

SUPPLEMENTARY INSTRUCTIONS TO RESPONDENTS

The San Antonio Water System (SAWS) Board of Trustees and/or its designated representative have determined that the Competitive Sealed Proposals method of procurement will provide the best value for SAWS for this project. This procurement shall conform to Section 2269 of the Texas Government Code.

This document provides general information about the requirements and evaluation for this Request for Competitive Sealed Proposals (RFCSP).

A. EVALUATION OF PROPOSALS

1. SAWS will conduct a comprehensive, fair and impartial evaluation of all Competitive Sealed Proposals received in response to this request within 45 days of receipt of the proposals. SAWS will appoint a selection committee to perform the evaluation. SAWS will evaluate and rank each proposal in relation to the following selection criteria:

Team Qualifications and Experience	**20%**
Quality, Reputation, and Ability to Deliver Projects on Schedule and within Budget	**20%**
Project Approach	**15%**
Price	**35%**
Small, Minority, and Women-owned Business Participation	**10%**
Total:	**100%**

2. During the evaluation and ranking of Respondents' proposals, SAWS reserves the right to consider the following:
   a. Whether the Respondent can perform the contract within the specified time. In making this determination SAWS may take into account Respondent's existing commitments and whether in SAWS' sole discretion those commitments will adversely impact Respondent's ability to complete the work in the scheduled time.
   b. The quality and punctuality of performance on any current or previous contacts.
   c. SAWS may contact references provided by the Respondent, as well as any other references to verify qualifications, experience and performance. In making this determination, SAWS may take into account work performed by the Respondent on any project, including but not limited to SAWS' projects, projects that the Respondent provides as references and any other projects that SAWS has knowledge of.
   d. Respondent's previous and existing compliance with the applicable laws, ordinances, permits, and regulations.
   e. Respondent's financial resources and ability to perform the contract.

3. If Respondent fails to provide a response to any of the Evaluation Criteria identified

within this RFCSP, points may be deducted or the proposal may be considered non-responsive and ineligible for consideration.

B. SUMMARY OF WORK

This Summary of Work is being provided to Respondents to better assist them in determining which projects are reasonably comparable to include as part of their proposal to this RFCSP. The work consists of the following:

a. Construction of approximately 5,800 LF of 42-inch gravity sanitary sewer installation via open cut and multiple bores.
b. Installation of large diameter gravity sewer within the 5-yr and 100-yr floodplain.
c. Careful planning and sequencing of construction activities to tie into existing sewer infrastructure.
d. Close coordination with several key stakeholders including but not limited to: Texas Department of Transportation (TXDOT), private property owners, and business owners.

Respondents should reference the Contract Documents prior to submitting a proposal for this RFCSP to fully understand the entire scope of work for this Project.

The decision of "comparability" when evaluating the Respondent's proposal is at the complete discretion of SAWS.

C. REQUIRED EXPERIENCE

Respondents submitting a proposal for this RFCSP should demonstrate, completely and sufficiently, that large diameter wastewater pipeline installations are a primary business focus and service, and such services have been successfully provided for at least five (5) continuous years.

D. DEFINITIONS

1. Personnel for the purpose of this RFCSP is defined as employees of the Prime Contractor, or any subcontractor(s), affiliates, joint venture partners, or team members, and consultants engaged by any of those entities.

2. The personnel specified below are considered by SAWS to be essential to the work being performed under this Contract, and as such are defined as Key Personnel. Key Personnel include the Project Manager, Construction Manager, Quality Assurance and Quality Control Lead, Project Scheduler, Project Superintendent, Open Cut Superintendent, and Boring / Tunneling Superintendent. Key Personnel shall be dedicated exclusively to this Project and shall be assigned as full-time employees for the duration of the Project. Prior to diverting any of the specified individuals to other projects, the contractor shall notify the Owner reasonably in advance and shall submit justification (including proposed substitutions) in sufficient detail to permit evaluation of the impact on the project. No diversion shall be made by the contractor without the

written consent of the Owner.

3. Subcontractor is defined in Article I, Contract Definitions of the General Conditions of the Contract Documents. Respondents should reference this definition prior to submitting a proposal in response to this Request for Competitive Sealed Proposals ("RFCSP").

4. Key Subcontractors are defined as subcontractors that are responsible for executing a significant portion of the work, and as such are deemed to be essential to the work being performed under this Contract. The Key Subcontractor roles could include boring, tunneling, and large diameter open cut pipe installation

E. RESPONSE FORMAT

1. Team Qualifications and Experience (20 Points)

a. Organizational Structure and Key Information of the Prime Contractor

i. Provide current business organizational structure, type of business structure, and stability of organization.
ii. Provide total number of employees and annual company revenues as of December 31, 2019.
iii. Provide Debarment history for the company for the last ten (10) years.
iv. Provide any litigation, arbitration, and claims history for the last three (3) years and any litigation, arbitration, and claims history with SAWS regardless of the year they occurred.
v. Indicate the number of years performing contracting/construction work under current legal business name and/or previous legal business name(s).
vi. Provide a clear description of the proposed team identifying Key Subcontractor(s), their role on the project, and teaming history. If the Prime Contractor has not worked previously with proposed Key Subcontractor(s), describe the proposed approach for ensuring successful completion of the project in accordance with Contract Documents.
vii. Provide a 1-page organizational chart that describes the composition of the team for this project. The chart shall include proposed Key Personnel for the Prime Contractor and Key Subcontractor(s). The chart shall also include percent availability (as percentage of total individual's workload) for Key Personnel (Prime and Key Subcontractor(s)) and their proposed role for the duration of the Project.
viii. Provide a clear description of the proposed team's Key Personnel roles and responsibilities, including Key Personnel from Key Subcontractor(s).
ix. Provide a financial statement prepared within the last twelve (12) months by an independent Certified Public Accountant.

- Respondent must clearly indicate the entity being proposed to enter into the Contract. In order to supplement the financial strength of the entity being proposed to enter into the Contract, the Respondent may, but is not required to, propose a guarantor who will guaranty the Contractor's obligations under the Contract through a separately

executed guaranty Contract in favor of SAWS. Only the financial information of (1) the entity being proposed to enter into the Contract, and (2) a guarantor, if proposed, will be considered in the financial evaluation of the RFCSP.

- SAWS in its sole discretion may reject any Respondent that does not possess the financial strength and capacity to undertake this project and the obligations and liabilities thereof. Subject to the complete review and finding of acceptability of the submitted financial information, Respondents demonstrating an ability to provide the required performance and payment bonds and the ability to maintain a minimum aggregate net worth sufficient to undertake this project, as measured by either the Respondent or a proposed Guarantor, shall be deemed to have the financial strength and capacity to undertake the project.
- The Respondent shall submit the financial information set forth below for the entity being proposed to enter into the Contract and any proposed guarantor. If Respondent is not a public company and believes any of its financial information is exempt from disclosure to third parties under the Texas Public Information Act in Chapter 552 of the Texas Government Code, the Respondent must clearly label the specific portions sought to be kept confidential and specify the exemption that the Respondent is relying upon. However, SAWS does not represent or guarantee in any way that Respondent's financial statements will be protected from disclosure, even if identified by Respondent as confidential or proprietary, in the event of a Public Information Request under Texas Government Code Chapter 552. SAWS will notify the Respondent of any public information requests relating to financial information marked as confidential by the Respondent, and the Respondent shall be responsible for defending its basis for exemption from disclosure in accordance with the Act.

    - If Respondent is organized as a corporation, partnership, LLP, LLC or joint venture, submit complete financial statements, including a Balance Sheet, Income Statement and Statement of Cash Flows, prepared in accordance with generally accepted accounting principles, for the most recent three complete fiscal years. Footnote disclosures must accompany the submitted year to date financial statements. If available, financial statements audited or certified by an independent certified public accountant should be submitted; otherwise, a notarized statement certifying the accuracy of the financial information and signed by an officer of the proposing entity must accompany the financial information. If any entity has been in existence less than three (3) years, the information shall be provided for the period of existence.

- If Respondent intends to organize as a partnership, LLP, LLC, or joint venture, then the above- referenced financial information of each partner, LLC/LLP member or joint-venture member must be submitted.
- SAWS reserves the right to obtain a Dun and Bradstreet financial report, or other credit report, at its own cost, and all members of your Team, responding to this RFCSP agrees to allow SAWS to obtain such report(s) on your Team members and all partners, affiliates and sub-consultants, if any, to facilitate SAWS' financial evaluation of the Respondent.

b. Qualifications and Experience of Key Personnel Proposed for this Project

i. On separate 8 ½" x 11" sheets, provide resumes, one per person and not to exceed one (1) page, for Key Personnel for the Prime Contractor and Key Subcontractor(s) identified on the organizational chart with the Project Manager's resume being first. Key Personnel resumes should include the following information:

- Name, title, education
- Number of years of total professional experience
- Number of years/months with current firm
- Number of years/months of experience in proposed role for this project
- Description of professional qualifications (to include degrees, licenses, certifications, and associations)
- Brief overview of professional experience
- Detailed description of capabilities and experience relevant to this Project
- List of all other active projects the team member is assigned to for the duration of the Project, to include the phase and percentage of time allocated to each of the other projects. For each project included in each resume, please clearly identify whether the project is with current firm or part of the person's past professional experience.

2. Quality, Reputation, and Ability to Deliver Projects on Schedule and within Budget (20 Points)

a. Prime Contractor On-time Completion on Similar Projects in the Past Ten (10) Years

i. List and describe five (5) <u>completed</u> projects within the last ten (10) years of similar size, scope, and complexity to the work described in the Contract Documents for this Project. Respondents should provide references with contact information to include a valid, recently verified email and telephone number for each project listed.

Each project should include the following information (using the evaluation forms provided):

- Project name.
- Utility/Owner name and contact information to include a valid, recently verified email and telephone number for Project Manager.
- List any Key Personnel also proposed on the W-1 project and the roles served by the proposed Key Personnel on the past project.
- Project is within the last ten (10) years.
- Project has similar size, scope, and complexity to the work described in the Contract Documents.
- Project description and why it is comparable to the size, scope, and complexity for this item.
- Original (bid/price) and final construction in place costs.
- Total costs for all change orders, as well as explanation regarding the reason for specific change orders.
- Construction Contract Notice to Proceed (NTP) Date.
- Original Contract Duration (Specify Calendar Days or Working Days).
- Original Contract Completion Date and Actual Completion Date.
- Actual number of days beyond the original contract. If Contract time extensions were added, provide a short explanation of each.
- The recovery schedule/plan and implementation of such, if it was required. If a recovery schedule/plan was implemented, describe whether the project was successfully brought back on schedule. Please discuss, as necessary and deemed appropriate.
- Describe any project specific challenges and how they were overcome.

ii. A minimum of two (2) of the five (5) projects listed must have been performed by the proposed Key Personnel (Project Manager, Construction Manager, Quality Assurance and Quality Control Lead, Project Scheduler, Project Superintendent, Open Cut Superintendent, and Boring / Tunneling Superintendent) for this Project.
- If Respondent has SAWS experience, at a minimum, one (1) SAWS project of similar size, scope, and complexity must be included in the list of five (5) projects provided, and

iii. The Respondent shall also list <u>all</u> current <u>and</u> recently completed large diameter (24-inch and larger) gravity sanitary sewer pipeline projects performed in the last five (5) years for all Utility Owners in the State of Texas. Respondent shall provide the following information for each project:
- Project name.
- Utility/Owner name.
- Date of Notice to Proceed.
- Project description and how it satisfies the large diameter (24-inch and larger) gravity sanitary sewer requirement for this section.
- Original Contract Time (Specify Calendar Days or Working Days).
- Original Contract Completion Date and Actual Completion Date. If project is not complete at the time of submission, Respondent shall provide the current % Complete based on contract time.

- Original (bid/price) and final construction in place costs. If project is not complete at the time of submission, Respondent shall provide the current % Complete based on contract value as of the most recent application for payment.
- Identify whether the project was completed on-time and within budget, as applicable.

b. Key Subcontractor(s) Performance on Similar Projects in the Past Ten (10) Years

The scope of this Project includes mostly open cut installation of sewer pipe. For the purposes of this RFCSP, pipe jacking, tunneling with liner plate, large diameter open cut pipe installation, and large diameter sanitary sewer bypass, are examples of Key Subcontractor's roles.

i. Provide a list of two (2) projects that the identified Key Subcontractors' Project Manager and/or Project Superintendent(s) participated in that were of similar size, scope, and complexity to the work described in the Contract Documents that have been completed within the last ten (10) years. Describe the role served by the proposed staff on those projects.

ii. If Prime Contractor is planning to self-perform the Work in accordance with the Contract Documents and no Key Subcontractor(s) have been identified in the Response, Respondent shall provide a list of two (2) additional projects that were of similar scope to the Work that would have been performed by a Key Subcontractor and that have been completed within the last ten (10) years. Prime Contractor's Key Personnel shall have participated in at least one (1) of the two (2) projects listed. Describe the role served by the proposed staff on those projects.

Each project should include the following information:

- Project name.
- Identify if the Project was performed by **Sub-Contractor** or if Prime Contractor **Self-Performed**
- Utility/Owner name and contact information to include a valid, recently verified email and telephone number for Utility/Owner Project Manager.
- List any Key Personnel also proposed on the W-1 project and the roles served by the proposed Key Personnel on the past project.
- Key Sub-Contractor's Project team(s) involved in this Project were identified on the organizational chart.
- Project is within the last ten (10) years.
- Project has similar size, scope, and complexity to the work described in the Contract Documents.
- Project description and why it is comparable to the size, scope, and complexity for this item.
- Original (bid/price) and final construction in place costs.
- Total costs for all change orders, as well as explanation regarding the reason for specific change orders.
- Construction Contract Notice to Proceed (NTP) Date.

- Original Contract Duration (Specify Calendar Days or Working Days).
- Original Contract Completion Date and Actual Completion Date.
- Actual number of days beyond the original contract. If Contract time extensions were added, provide a short explanation of each.
- The recovery schedule/plan and implementation of such, if it was required. If a recovery schedule/plan was implemented, describe whether the project was successfully brought back on schedule. Please discuss, as necessary and deemed appropriate.
- Describe any project specific challenges and how they were overcome.

If valid contact information is not provided, the project may not be considered and the Respondent's score for this criteria may be reduced and/or Respondent's proposal may be deemed non-responsive.

3. Project Approach including Delivery Schedule (15 Points)

a. Project Approach

i. Provide a narrative of the project approach describing how the Respondent will complete this project. Include key milestones, specific critical processes and critical path items, phases and/or sequencing, permits, approvals, coordination with stakeholders, and procurements anticipated to complete the project work. Identify potential risks and describe proposed mitigation measures to ensure on-time completion of the Project.

ii. Describe availability of equipment and facilities that will be specifically utilized for this Project.

iii. Explain how Respondent will contact and coordinate with key stakeholders throughout the Project. Describe how the Respondent will coordinate with property owners and business owners being impacted by the Project. Describe the Respondent's approach for securing permits (e.g., ROW, SWPPP, etc.) and/or complying with permit requirements for which SAWS is the permit holder (TXDOT including traffic control, COSA Tree Permit, COSA Floodplain, USACE, etc.).

iv. Provide any innovative ideas for cost savings (due to method or duration) for this project.

v. Provide a quality management plan describing how the Prime Contractor will ensure that the necessary steps, safeguards, subcontractor oversight, Quality Assurance/Quality Control processes, and document controls will be implemented in a rigorous manner as to ensure the completeness, workmanship, accuracy, and successful completion of the Project.

b. Project Schedule, Procurement of Long-Lead Items, and Unforeseen Conditions

i. Provide a detailed, precedence style critical path method (CPM) baseline schedule in Primavera or Microsoft Project. The baseline scheduled must encompass the entire contract duration from Notice to Proceed to the Contract End Date. The baseline schedule must show a completion date (or early

completion date) that corresponds to the Contract End Date. The baseline schedule must be inclusive of all work necessary to complete the project including sufficient time necessary for submission and review of submittals, permits, etc. The schedule shall take into consideration sequencing and contractual limitations as described within the Contract Documents. The anticipated notice to proceed (NTP) for this Project is February 8, 2021. Respondent shall use this date for developing the proposed project schedule.

ii. Provide a description of the project approach for procuring long-lead items, as well as for ensuring critical path items will be addressed adequately.

iii. List and describe any instances in which the Contractor has encountered unforeseen conditions.
- Identify whether a recovery plan was required.
- Describe the nature of the issue and whether it was promptly resolved or resulted in the Respondent being asked to demobilize.

iv. Describe the Respondent's approach towards mitigating and managing unforeseen conditions should they be encountered during the construction of this Project.

4. Safety Information for Prime Contractor and Key Subcontractor(s) (Pass/Fail)

i. Provide records showing Total Recordable Incident Rate (TRIR) for each year for the past five (5) years for the Prime Contractor and Key Subcontractor(s).

ii. Provide records showing the company's Experience Modification Rate (EMR) for the past three years for the Prime Contractor and Key Subcontractor(s).

iii. List any fatalities in the company's safety history for the Prime Contractor and Key Subcontractor(s).

5. Price Proposal (35 Points)

The Proposal with the lowest total price will receive thirty-five (35) points. Proposals will receive a percentage of the thirty-five (35) points based on a comparison with the lowest total price proposal as described below.

Computation Steps:

i. Step 1. Determine lowest total price and award 35 points for price.

ii. Step 2. Calculate the ratio between the lowest total price and each proposal. Multiply the ratio by 35 to obtain the points earned.

Proposal	Price	Calculation	Points Earned
A	$22,995,000	(12,875,000/22,995,000) x 35	19.60
B	$19,875,000	(12,875,000/19,875,000) x 35	22.67
C	$16,625,000	(12,875,000/16,625,000) x 35	27.11
D	$12,875,000	(12,875,000/12,875,000) x 35	35.00

Proposal	Price	Calculation	Points Earned
E	$15,250,000	(12,875,000/15,250,000) x 35	29.55

6. Small, Minority, Woman, and Veteran-Owned Business Participation

a. Equal Employment Opportunity Requirements - SAWS highly encourages Respondents to implement Affirmative Action practices in their employment programs. This means Respondents should not discriminate against any employee or applicant for employment because of race, color, religion, sex, pregnancy, sexual orientation, national origin, political belief or affiliation, age, disability or genetic information.

The SAWS Board of Trustees has adopted a Small, Minority, Woman, and Veteran-owned Business (SMWVB) Policy to establish and oversee a program that will support the inclusion of local small, minority, woman, and veteran-owned businesses (SMWVB). It is the policy of SAWS that it will ensure that local small, minority, woman, and veteran-owned businesses have an equal opportunity to compete for, receive and participate in SAWS contracts. It is our policy to:

- Ensure nondiscrimination in the award and administration of SAWS contracts;

- Create a level playing field on which SMWBs can compete fairly for SAWS contracts;

- Ensure that only firms that attempt to meet small, minority, and woman-owned business good faith efforts are considered for contract awards.

Respondent's commitment to SAWS SMWB policy will be based on meeting or exceeding the minimum aspirational SMWB goal of 20%. The minimum goal is based on the total contract value. Points will be awarded based on the following tiered scales.

Please note that as of 1/1/2017, an updated SMWVB Policy and scoring methodology are being implemented by San Antonio Water System. Veteran-owned Business Enterprises (VBEs), are tracked for statistical purposes, but are not eligible for points. **The maximum number of Small, Minority, and Woman-owned Business (SMWB) points to be earned is 10 points.** Self-performance and subconsulting may be used to achieve the aspirational goals and earn points. **SMWB Respondents and/or subconsultants must be certified by the South Central Texas Regional Certification Agency**. **Eligible firms (including MBEs and WBEs) must also be certified as a Small Business Enterprise (SBE), must perform a commercially-useful function on the project, and must have a local presence in the San Antonio Metropolitan Statistical Area in order to be counted for SMWB points**. Please see the Good Faith Effort Plan for definitions of terms. All Respondents, whether SMWB or not, may earn the **maximum number of SMWB points (10)** by adhering to any combination of the following point structures when attempting to meet the aspirational goals:

A. M/WBE Scoring Method: Up to 10 Points (By percentage). **20.00% M/WBE Participation**
• MBE Participation Percentage between 1% and 4.99%: 1 Point
• MBE Participation Percentage between 5% and 9.99%: 2 Points
• MBE Participation Percentage between 10% and 14.99%: 4 Points
• MBE Participation Percentage between 15% and 16.99%: 5 Points
• MBE Participation Percentage between 17% and 19.99%: 8 Points
• MBE Participation Percentage meeting or exceeding 20.00%: 10 Points
B. SBE (Non-M/WBE) Scoring Method (for participation of firms whose sole certification is "SBE"): Up to 5 Points (By percentage). **5% SBE Participation:**
• SBE Participation Percentage between 1% and 1.99%: 1 Point
• SBE Participation Percentage between 2% and 2.99%: 2 Points
• SBE Participation Percentage between 3% and 3.99%: 3 Points
• SBE Participation Percentage between 4% and 4.99%: 4 Points
• SBE Participation Percentage meeting or exceeding 5.00%: 5 Points
C. **Optional:** Prior subcontractors/supplier utilization compliance averages for the past 2 years may be considered when totaling the SMWB score, based upon data from the Subcontractor Payment & Utilization Reporting (SPUR) System. This applies to SMWB and Non-SMWB Prime Contractors' utilization of their SMWB subcontractors/suppliers. Up to 3 points may be deducted from the SMWB score for discrepancies between the pledged SMWB goal, and the current/ongoing actual utilization of SMWB subcontractors/suppliers on recent SAWS projects. This option does not apply to work order/unspecified contracts.
• Total SMWB Subconsultant compliance discrepancy between 3% - 4%: Deduct 1 Point
• Total SMWB Subconsultant compliance discrepancy between 4% - 5%: Deduct 2 Points
• Total SMWB Subconsultant compliance discrepancy greater than 5%: Deduct 3 Points

b. All firms submitted as SMWVB must provide a copy of their certification certificate.

c. The SMWB goal is expressed as a percentage of the total dollar amount of the contract going to SMWBs for those areas which the Respondent has subcontracted or anticipates to subcontract, including any future change orders. The goal shall also apply to change orders that require work beyond the scope of services originally required to accomplish the project.

d. The Respondent agrees to employ good faith efforts to carry out this policy through award of subcontracts to SMWVBs to the fullest extent possible.

e. The SAWS Good Faith Effort Plan (GFEP) will be used for scoring purposes based

upon SMWB participation. However, **all subcontractors and/or suppliers, whether SMWVB-certified or not, must be listed in the GFEP**, because the information provided in the GFEP will be utilized in the development of the final contract/agreement. The GFEP format is attached as Exhibit "B." This form is required and considered part of the response to the RFCSP. Should the Good Faith Effort Plan not be submitted, the proposal may be considered non-responsive.

f. The S.P.U.R. System is accessed through a link on SAWS' "Business Center" web page. The Respondent and all subcontractors will be provided a unique login credential and password to access the SAWS subcontractor payment reporting system. The link may be accessed through the following internet address: https://saws.smwbe.com/.

Training on the use of the system will be provided by SAWS. After the Respondent receives payment from SAWS, electronic submittals will require data entry of the amount paid to each subcontractor listed on the Contractor's Good Faith Effort Plan.

g. Please contact the SMWVB program manager, Marisol V. Robles, at 210-233-3420 or marisol.robles@saws.org for any questions pertaining to the Good Faith Effort Plan or the SMWVB Program.

F. FORMAT OF PROPOSALS

1. Proposals shall be prepared simply and economically, providing a straightforward, concise description of the Respondent's ability to meet the requirements of this RFCSP. Emphasis shall be on the quality, completeness, clarity of content, responsiveness to the requirements, responsiveness to the evaluation criteria, and an understanding of SAWS needs.

2. Respondents shall utilize the fillable evaluation criteria forms provided by SAWS to prepare their response to the RFCSP and should reference the Required Documents Matrix, which identifies which documents are required and won't count toward the page limit. Proposals shall be a MAXIMUM OF TWENTY-FIVE (25) PRINTED PAGES, for those pages that do count towards the page limit. Respondents shall respond to each section fully, but are not obligated to use every page set by the limit and are allowed the flexibility to use this page limit as they see fit.

3. Proposals shall be submitted in three (3) pdf files electronically. Respondents should reference the revised Respondent's Proposal Checklist to ensure all required items are included.

4. Respondents shall carefully read the information contained in this RFCSP and submit a complete response to all requirements and questions as directed. Incomplete Proposals will be considered non-responsive and subject to rejection.

5. Proposals and any other information submitted by Respondents in response to this

RFCSP shall become the property of SAWS.

6. Proposals shall be prepared using letter-size 8-1/2" x 11" pages. The project schedule and Team Organizational Chart can be prepared using tabloid-size 11" x 17" pages.

7. Respondents shall utilize the Respondent's Proposal Checklist provided in this RFCSP and must provide page numbers for all pages of the proposal.

8. Separate and identify each evaluation criteria response of this RFCSP by use of a divider sheet for ready reference in the order indicated within the Respondent's Proposal Checklist.

9. The pdf of the Respondent's Original proposal shall contain the entire proposal package as submitted, excluding the financial statement, Good Faith Effort Plan, and Price Proposal.

SUPPLEMENTAL SPECIFICATIONS

SS 853 – Glass-Fiber Reinforced (FRP) Manholes

SS 1050 – Survey Controls

SS 2140 – Control of Ground and Surface Water

SS 2218 – Low Density Cellular Grout Fill

SS 2242 – Water Control for Shaft Tunnel Construction

SS 2314 – Tunneling with Steel Liner Plate

SS 2315 – Portal Stabilization

SS 2400 – Tunnel Shafts

SS 2426 – Carrier Pipe in Tunnels

SS 2441 – Pipe-Jacked Tunnels

SS 2442 – Direct Pipejacking Tunnels

SS 2445 – Settlement Monitoring

SS 2610 – Steel Casing Pipe

SS 3360 – Contact Grouting

PART 1 - GENERAL

1.01 SUMMARY

A. This section is a supplement to Item No. 853 Sanitary Sewer Glass-Fiber Reinforced Polyester (FRP) Manholes of SAWS Specifications for Water and Sanitary Sewer Construction.

B. This section governs the furnishing and installing of FRP tee-base manholes and manhole rings and covers.

1.02 REFERENCES

A. ASTM D3753 – Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells.

B. Standard Specifications for Public Works Construction, City of San Antonio, Texas.

C. San Antonio Water System Specifications for Water and Sanitary Sewer Construction.

1.03 DELIVERY, STORAGE AND HANDLING

A. Handling, transporting and storage shall be in accordance with the manufacturer's instructions.

B. All manholes are subject to inspection by the Engineer. Material found to be defective due to manufacture or damage in shipment shall be rejected and removed from the job site.

C. Manholes shall be loaded and unloaded by a means to prevent shock or damage. Under no circumstances shall such material be dropped.

D. Manholes, if stored, shall be kept safe from damage. The interior of all manholes shall be kept free from dirt or foreign matter at all times.

1.04 SUBMITTALS

A. All construction shop drawings related to fabrication, assembly and installation along with all detailed product/material specifications shall be submitted in accordance with San Antonio Water Systems' General Conditions. Complete fabrication, assembly, and installation drawings, together with detailed specifications and data covering materials, shall be submitted in accordance with the submittals section. The data and specifications shall include, but shall not be limited to, the following for each size and class of pipe:

1. Details of joints

2. Gasket material

3. Pipe length

4. Details of fittings and specials

5. Test reports

6. Laying schedule

7. Certification in accordance with ASTM D3753

PART 2 - PRODUCTS

2.01 MANHOLES OVER EXISTING SEWER LINES

A. Where manholes are indicated on the drawings to be constructed over existing sewers, the existing sewer pipe shall be left undisturbed and the flow maintained through it until the manholes have been completed and accepted or until the receiving facility to where the flow is being diverted is ready to accept the flow.

B. Existing sewer lines must be properly plugged before being cut and a pump shall be provided to divert sewage from the manhole directly upstream of the sewer line to be cut to a downstream manhole. Bypassed sewage shall not be directed onto the ground or into any receiving streams.

C. Unless otherwise specified, required or ordered by the Engineer, the CONTRACTOR shall carefully excavate around and properly support the existing sewer pipe.

D. On completion and acceptance of the manhole, the top portion of the existing sewer pipe shall be carefully removed and the flow channel formed to the limits and in accordance with the details shown on the drawings.

E. The Engineer or SAWS' inspector must be present when the existing pipe is cut for manholes over existing sewer lines.

F. Where manholes are constructed over existing sewers, the base slab may be cast-in-place or precast concrete and shall have reinforcing bars extending into the concrete fill used for the flow channel and bench. The manhole section shall have openings provided to fit over the existing pipe(s). The opening around the existing pipe(s) shall be sealed with concrete when forming the flow channel to the top of the bench and the remaining opening above the bench with concrete and mortar.

2.02 DROP MANHOLES

A. Drop manholes shall be constructed as shown on the Plans.

2.03 TEE-BASE MANHOLES

A. Description – Manhole tee bases shall be constructed of mitered sections of FRP sewer pipe connected with fiberglass reinforced laminations.

B. Dimensions – Diameter and length of the tee base through section and vertical leg shall be as shown on the project drawings or as agreed between the purchaser and supplier, and approved by the Engineer.

C. Class – Pipes used to construct the tee base shall have the same stiffness as the adjacent line piping.

D. Alignment Changes – Fabricate the tee base through section with a mitered elbow configuration to achieve the required angles shown on the project plans. Maximum angle of each miter is 30 degrees.

E. Elevation Changes – Construct drop configurations as shown on the plans.

F. Diameter Changes – Accommodate diameter changes at manholes using a reducer on the upstream side of the tee base.

G. Joints – Assemble the tee base to the line pipes using the same gasket-sealed joint as pipe to pipe connections or another gasket-sealed joint approved by the Engineer.

2.04 MANHOLE RISER PIPE

A. The Riser Pipe section of the manhole shall be fiberglass in conformance with Specification Section 853 Sanitary Sewer Glass-Fiber Reinforced Polyester (FRP) manholes.

B. Dimensions of the Riser Pipe shall be shown on the project drawings.

END OF SECTION

PART 1 – GENERAL

1.01 SURVEY CONTROLS

A. Contractor shall use a qualifications-based selection process consistent with the Professional Services Procurement Act, Chapter 2254.004 of the Texas Government Code, when securing the services of a Professional Engineer or Registered Professional Land Surveyor. It is a violation of State Law to solicit bids for the services of a Professional Engineer or Registered Professional Land Surveyor. All survey work will be performed under the direct supervision of a Registered Professional Land Surveyor (RPLS) licensed in the State of Texas.

1.02 CONSTRUCTION STAKING

A. All references in this section to Contractor and requirements of Contractor related to survey shall be understood to require a RPLS to perform the work and provide a signed and sealed report or documentation as indicated.

B. Prior to start of construction the Contractor shall locate and verify all project survey control monuments shown on the Contract Documents to ensure that they have not been disturbed or destroyed. The Contractor shall notify SAWS and Engineer of any control that cannot be located or that appears to be unusable. The Engineer will have a Registered Public Land Surveyor (RPLS) reset the control in a timely manner.

C. Once Contractor verifies control monuments, Contractor shall protect all monuments for the duration of construction. Contractor may set additional reference points or control points as needed.

D. SAWS will not be responsible for any staking associated with the construction of the project.

E. Contractor shall submit certified cut sheets to SAWS and Engineer within (24) hours of performing contract staking. All stakes shall be set on an offset that will be clear of the excavation of the intended infrastructure. All cut sheets shall identify benchmarks and control points used, elevations of these points, actual stake elevations, proposed elevations, and cut elevations.

F. Contractor shall submit construction staking layout sheets sealed by a Professional Engineer or Registered Professional Land Surveyor licensed in the State of Texas.

G. Contractor shall promptly submit any and all information associated with the cut elevation that may result in elevations that differ from those shown in the Contract Documents, such as, over excavation, embedment depths, and flow line elevations. Contractor shall obtain concurrence from SAWS and Engineer prior to performing any work that may be impacted by such differing elevations.

H. Line and grade stakes shall be set every 25 feet for the first 100 feet out of the downstream manhole, and every 100 feet throughout the project. Stakes shall be set based on the centerline stationing.

I. The Contractor shall place grade stakes and submit construction staking layout sheets. The Contractor shall allow a minimum of ten (10) days after submission to SAWS and Engineer for review of construction staking layout sheets. Construction staking layout sheets shall include, at a minimum, the information contained in the form included at the end of this section. No work shall be performed without Engineer's review and return to Contractor of construction staking layout sheets.

J. The Contractor is required to provide a sealed statement from the RPLS retained for the project that the controls are correct and the site layout has been completed by their professional staff.

K. Any re-staking required of the contractor to meet the above requirements shall be at the Contractor's expense.

1.03 LINE AND GRADE VERIFICATION

A. Surveying will be coordinated between SAWS and Contractor in a manner convenient to all parties.

B. The Contractor's RPLS shall verify line and grade of every manhole constructed within the project scope. The survey of the pipe flowline shall be completed immediately once the manhole has been set and once initial backfill has begun. The flowline of each pipe (in and out) within the manhole shall be surveyed, documented, and immediately submitted to SAWS for review. The contractor shall not continue with any additional pipe installation beyond the first joint upstream of the manhole until the manhole elevation has been certified by the Contractor's RPLS and such certification has been submitted to and acknowledged by SAWS.

C. The Contractor shall neatly and legibly record the information in a field book during construction and provide copies of the surveyed elevation as well as all manhole elevation reports from the RPLS on a monthly basis with each pay application.

D. If the line and grade of the pipe differs from that shown on the Contract Documents, the Contractor shall immediately notify SAWS and Engineer of the discrepancy and highlight the discrepancy in the field book.

E. In the event the line or grade of the pipe deviate beyond the allowed tolerances, the contractor shall remove and reinstall the manhole and pipe in accordance with the Contract Documents, at no additional cost to SAWS or Engineer. A time extension to the Contract will not be granted.

F. The horizontal tolerances shall never exceed six (6) inches from the centerline station unless prior approval is provided by SAWS and/or Engineer. No deflection between two joints of pipe shall exceed one half of the manufacturer's specifications. Corrections to the

horizontal alignment to regain centerline control shall meet the deflection specifications of the pipe manufacturer. If horizontal deflections are made, the contractor shall submit a plan for how the Contractor plans to complete and correct the deflection. All deflections shall be glassed and sealed by a representative of the pipe manufacturer authorized to complete the glassing.

G. The vertical tolerances for pipe installation shall not exceed the elevations shown in the Contract Documents while also maintaining a positive, downstream flow. The vertical tolerance shall never exceed a maximum of 0.6 inches (or 0.05 ft) if all other conditions are met and such tolerances will only be allowed if all other conditions are met.

H. The maximum tolerances provided are based on an average and shall not be considered an allowable continuous tolerance over the length of the pipe.

I. The following requirements take precedence over the specified tolerances:

   a. Meeting the Texas Commission on Environmental Quality (TCEQ) minimum and maximum slope requirements and velocity requirements.

   b. Maintaining elevations for proper connections to existing utilities including downstream and upstream manhole connections and lateral connections.

   c. Maintaining elevations for proper connections to proposed infrastructure shown to be constructed “by others” in the Contract Documents.

   d. Maintaining elevations for proper connections to proposed infrastructure to be installed by the Contractor such as bores, tunnels, and lateral stubouts.

J. No direct payment shall be made for costs associated with the quality control measures required of the Contractor to maintain line and grade through the entirety of construction.

PART 2 – MEASUREMENT AND PAYMENT

Survey controls shall be considered subsidiary to the work as a whole.

CONSTRUCTION STAKING LAYOUT SHEET

Project Name: _____ **Date:** _____
C.I.P. ID#: _____ **Instrument No.:** _____
Person Recording: _____ **Weather Conditions:** _____
1.04 CREW MEMBERS: _____
General Purpose & Scope of Survey: _____

STATION	B.S.	H.I.	F.S.	LEVEL LOOP ELEVATION	ROD READING	HUB ELEVATION AT STATION	TARGET (e.g., pipe invert) ELEVATION	C – CUT OR F - FILL	% GRADE	NOTES: INDICATE WHETHER CENTERLINE HUB OR _____ FT. OFFSET HUB

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section provides for furnishing all labor, materials, equipment, power, and incidentals for performing all operations necessary to dewater, depressurize, drain, and maintain excavations as described herein and as necessary to operate pumps, installation of pipeline and appurtenances. Included are installing, maintaining, operating and work removing dewatering systems, and all work necessary to control, handle, and dispose of groundwater and surface water during the construction of open cut trench and shaft excavations, directional drilling, pipelines and appurtenances, and protecting Work against rising waters and repair of any resulting damage at no additional cost to SAWS.

B. Work includes reduction of hydrostatic pressure and control of groundwater and perched groundwater in open cut trench and shaft excavations to provide dry and stable subgrade for construction. The work also includes the design, procurement, and installation of facilities to satisfactorily treat water, if required, for discharge to drainage system.

C. Protecting work against surface runoff and rising flood water.

D. Conformance to SWPPP.

1.02 CONTRACTOR'S RESPONSIBILITY

A. It is the sole responsibility of the Contractor to identify groundwater and surface water conditions and to provide any and all labor, material, equipment, techniques, and methods to lower, control and handle groundwater and surface water as necessary for the Contractor's construction methods and to monitor the effectiveness of this installed system and its effect on adjacent facilities.

B. Operate, maintain, and modify the system(s) as required to conform to these Specifications. Upon completion of the construction, Contractor shall remove the system(s). The development, drilling and abandonment of all wells used in the dewatering system shall comply with Texas Commission on Environmental Quality regulations and Texas Water Well Drillers Association.

C. Assume sole responsibility for dewatering systems and for all loss or damage resulting from partial or complete failure of protective measures and any settlement or resultant damage caused by the dewatering operations. Modify groundwater control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, or adjacent wells. Repair damage caused by the dewatering system or resulting from failure of the system to protect property as required.

D. Provide an adequate number of piezometers installed at the proper locations and depths as required to provide meaningful observations of the conditions affecting the excavation adjacent structures, and wells.

1.03 DEFINITIONS

A. Ground water control system: system used to dewater and depressurize water-bearing soil layers.

1. Dewatering: lowering the water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts; and disposing of removed water. Intent of dewatering is to increase stability of tunnel excavations and excavated slopes; prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of excavations, and to provide suitable conditions for placement of backfill materials and construction of structures and other installations.

2. Depressurization: includes reduction in piezometric pressure within strata not controlled by dewatering alone, necessary to prevent failure or heaving of excavation bottom or instability of tunnel excavations.

B. Excavation drainage: includes keeping excavations free of surface and seepage water.

C. Surface drainage: includes use of temporary drainage ditches and dikes and installation of temporary culverts and sump pumps with discharge lines necessary to protect Work from any source of surface water.

D. Monitoring facilities for groundwater control system: includes piezometers, monitoring wells and flow meters for observing and recording flow rates.

1.04 DESIGN CRITERIA

A. Geotechnical data and anticipated groundwater conditions are described in the Geotechnical Data Report prepared by HVJ Associates, dated December 10, 2019. The Contractor shall be responsible for dewatering design and selection of methods and equipment for the dewatering system. The design shall be performed and stamped by a professional engineer registered in the State of Texas and specialized in hydrogeology or geotechnical engineering. Design shall include the monitoring and recording system.

B. Dewatering systems shall be designed to satisfy the following objectives:

1. Effectively reduce hydrostatic pressures, lower groundwater levels, and intercept perched groundwater to provide a dry and stable subgrade for the execution of subsequent operations.

2. Not result in damage to existing adjacent properties, buildings, structures, utilities, and other work.

3. Assure that after 12 hours of initial pumping, no soil particles will be present in the discharge water.

4. Comply with requirements for sanitary sewer discharge as described in Paragraph 3.08 of this Section.

5. Maintain stability of sides and bottom of excavations.

C. Required methods may include sump pumping, single-stage or multiple-stage well point systems, eductor and ejector-type well systems, deep wells, and combinations thereof. Groundwater cutoffs are also acceptable provided groundwater inflows at hydrostatic pressures are controlled so that the Work can be performed in the dry and so that there is no seepage or loss of ground.

D. Locate dewatering facilities within the proposed and temporary easements, JUAs, and only where they will not interfere with utilities, traffic, pedestrians, or construction work to be done by others.

E. Contractor shall modify dewatering or groundwater control procedures that cause or threaten to cause damage to new or existing facilities, so as to prevent further damage. The Contractor shall be responsible for determining and making the modifications at no additional cost to SAWS.

F. Dewatering facilities, monitoring wells, and piezometers shall be made accessible to the Engineer at any time for monitoring purposes.

G. Additional monitoring wells and piezometers may be requested by the Engineer or SAWS to be installed by the Contractor, at no additional cost to SAWS. Monitoring wells and piezometers shall be accessible to SAWS at all times.

H. Dewatering and monitoring wells shall be installed and abandoned per Texas Commission on Environmental Quality Rules and Regulations.

I. Provide ditches, berms, pumps and other methods necessary to divert and drain surface water from excavation and other work areas.

1.05 QUALITY REQUIREMENTS

A. Provide for the arrangement, locations and depths of the dewatering system to accomplish the Work and satisfy the requirements specified herein. Provide sumps, well points, and deep wells with suitable filters and well screens of adequate size and screen opening to prevent removal of fines from the soils. Make available equipment, machinery and piping, including standby power and pumps in good working condition and of adequate capacity to continue dewatering operations in an emergency.

B. Provide dewatering and/or groundwater control as required and as specified until the pipe or structure under construction has been completed.

C. Dispose of water in closed conduits, do not to damage public or private property or create a nuisance or health hazard. Contractor to shall not use existing sanitary sewer system for discharge of groundwater and/or surface water flow.

1.06 SUBMITTALS

A. Prior to the installation of the dewatering system and any excavation where groundwater is anticipated to be encountered, submit a Groundwater and Surface Water Control Plan for review by SAWS and Engineer prior to start of any fieldwork. The Plan shall be signed by a Professional Engineer registered in the State of Texas. Submit a plan to include the following:

1. Results of any subsurface investigation and description of the extent and characteristics of water bearing layers subject to groundwater control.

2. Design data, and descriptions of proposed groundwater and surface water control facilities for each location where these facilities are required.

3. The proposed type of dewatering or groundwater control system including a description of the methods, equipment, standby equipment and power supply, observation wells and/or piezometers, pollution control facilities, and discharge locations to be utilized.

4. Arrangement, location and depth of the components of the proposed system. A complete description of the equipment to be used with associated installation, operation, and maintenance procedures.

5. Location and size of wells, berms, dikes, sediment pits, and discharge lines, including their relation to existing drainage facilities.

6. Excavation drainage methods including typical drainage layers, sump pump application and other means.

7. Surface water control and drainage installations.

8. Proposed methods and location for disposing of removed water.

9. A schedule for the installation of the system.

10. Working Drawings and supporting calculations demonstrating the adequacy of the proposed system and equipment prepared by a professional engineer registered in the State of Texas and specialized in hydrogeology or geotechnical engineering.

11. Include QA/QC process that ensures the Contractor's management of groundwater and surface water control does not impede construction or existing infrastructure.

12. The submittal of dewatering and groundwater control systems shall be made at least 45 days from the Contractor's notice to proceed. The Contractor shall resubmit if the system is modified during installation or operation.

B. Submit the following records upon completion of initial installation:

1. Installation and development reports for well points, eductors, and deep wells.

2. Installation reports and baseline readings for piezometers and monitoring wells shall be provided monthly.

3. Baseline analytical test data of water from monitoring wells.

4. Initial flow rates.

C. *Submit the following records weekly during control of ground and surface water operations:*

1. Records of flow rates and piezometric elevations obtained during monitoring of dewatering and depressurization. Refer to Paragraph 3.04, Requirements of Eductor, Well Points, or Deep Wells.

2. Maintenance records for groundwater control installations, piezometers and monitoring wells.

1.07 SITE CONDITONS

A. The Contractor shall be responsible for the continuous control of water and safety of excavations at all times during the course of construction, including weekends and holidays and during periods of work stoppages, and shall provide adequate backup systems to accomplish control of water. The method of control, handling, and disposal of groundwater and surface water shall be by whatever means are necessary and in conformance with this section to obtain satisfactory working conditions and maintain the progress of the work. All applicable legislative statutes, judiciary decisions, and regulations shall be followed including those pertaining to the use of drilled wells for dewatering.

B. All required drainage, pumping, and disposal shall be done without damage to adjacent property or structures, and without interference with the operations of other contractors, or the rights of public or private owners, or pedestrian and vehicular traffic. The Contractor shall modify the water control system at no cost to SAWS if, after installation and while in operation, it causes or threatens to cause damage to adjacent property or to existing buildings, structures, or utilities.

C. Repair, subject to the Engineer’s acceptance, any damage, disruption, or interference resulting directly or indirectly from dewatering operations at no additional cost to SAWS.

D. Comply with requirements of agencies having jurisdiction.

E. Comply with Texas Commission on Environmental Quality regulations and Texas Water Well Drillers Association for development, drilling, and abandonment of wells used in dewatering system.

F. Obtain permit from TCEQ under the Texas Pollutant Discharge Elimination System (TPDES), for storm water discharge from construction sites.

G. Obtain all necessary permits from agencies with jurisdiction over use of groundwater matters affecting well installation, water discharge, and use of existing storm drains and natural water sources. Since review and permitting process may be lengthy, take early action to obtain required approvals.

H. Groundwater conditions are described in the Geotechnical Data Report prepared by HVJ Associates, dated December 10, 2019.

I. *All dewatering operations shall be set up and operated within the construction limits shown, or within public rights-of-way unless written approval is received by the Contractor from the private property owner.*

J. *Dewatering systems shall not interfere with areas required for vehicular and pedestrian traffic.*

K. *Select equipment and materials necessary to achieve desired results for dewatering. Selected equipment and materials are subject to review by SAWS and Engineer through submittals required in Paragraph 1.06, Submittals.*

L. *Use experienced contractors, regularly engaged in groundwater control system design, installation, and operation, to furnish and install and operate educators, well points, or deep wells, when needed.*

M. *Maintain equipment in good repair and operating condition. Ensure pumps are properly cleaned and maintained to ensure pump performance.*

N. *Keep sufficient standby equipment and materials available to ensure continuous operation, as required. Pumps need to be properly cleaned and maintained to ensure pump performance.*

PART 2 - PRODUCTS

2.01 MATERIALS

A. Dewatering systems: The design of the dewatering systems, and the selection of equipment and materials for the dewatering systems shall be the Contractor's responsibility and conform to the following:

1. Where vertical shoring systems are used, wells shall be used and located outside of the shoring system.

2. Equipment and materials determined by the Engineer to be unsound, inadequate, or unsuitable for the intended purpose shall be removed from the site and replaced with other approved items.

3. Install observation wells and/or piezometers as required to demonstrate that dewatering system design requirements have been achieved.

B. Pumps and dewatering wells shall be provided with totalizing flow meters to accurately determine flow rates and the quantity of water pumped. Flow meters shall be installed no closer than 4 feet from any bend in the discharge pipe.

PART 3 - EXECUTION

3.01 SURFACE DRAINAGE

A. Surface drainage shall be intercepted and diverted away from the Work sites by the use of dikes, curbwalls, ditches, sumps (with pumps), or other means. Surface drainage systems shall be designed so that they do not cause erosion on or off the site. Surface runoff shall be controlled to prevent entry of water into excavations. Drainage systems shall be removed when no longer needed.

B. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction. Provide settlling basins when required by agencies.

C. Water collected from surface drainage system shall be managed in a manner that prevents releasing hazardous substances to surface or subsurface soil or groundwater, except as specifically authorized by any applicable discharge permit.

3.02 GROUNDWATER CONTROL IN SHAFT AND TRENCH EXCAVATIONS

A. Perform necessary subsurface investigation to identify water bearing layers, piezometric pressures and soil parameters for design and installation of ground water control systems. Perform pump tests, if necessary to determine draw down characteristics. Present results

in the Ground Water and Surface Water Control Plan submittal. Contractor shall expedite subsurface investigations in order to include information in the Ground Water and Surface Water Control Plan.

B. Provide labor, material, equipment, techniques and methods to lower, control and handle ground water in a manner compatible with construction methods and site conditions. Monitor effectiveness of installed systems and their effect on adjacent property.

C. Install, operate, and maintain ground water control systems in accordance with the Ground Water and Surface Water Control Plan. Notify SAWS and Engineer in writing of changes made to accommodate field conditions and changes to Work. Provided revised drawings and calculations with notification.

D. Provide continuous system operation, including nights, weekends, and holidays, as required. Arrange appropriate backup if electrical power is primary energy source for dewatering system.

E. Monitor operations to verify systems lower ground water piezometric levels at rate required to maintain dry excavation resulting in stable subgrade for subsequent construction operations.

F. Continue dewater in all required areas, until the involved Work is completed, including the placing and compaction of backfill materials in dry conditions and in accordance with the Contract Documents.

G. Depressurize zones where hydrostatic pressures in confined water bearing layers exist below excavations to eliminate risk of uplift or other instability of excavation or installed works. Define allowable piezometric elevations in the Ground Water and Surface Water Control Plan.

H. Provide a uniform diameter for each pipe drain run constructed for dewatering. Remove the pipe drain when it has served its purpose. If removal of the pipe is impractical, provide grout connections at 50-foot intervals, and fill the pipe with cement-bentonite grout or cement and sand grout when the pipe has served its purpose.

I. Removal of ground water control installations.

J. Remove pumping system components and piping when ground water control is no longer required.

K. Remove monitoring wells when directed by SAWS.

L. Grout abandoned well and piezometer holes. Fill piping that is not removed with cement-bentonite grout or cement-sand grout.

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

N. Compact backfill to not less than 98 percent of maximum dry density in accordance with SAWS Specifications.

O. The Contractor shall monitor and record, on a daily basis, the volume of water pumped per calendar day from shaft and trench excavations, using flow measuring devices approved by the Engineer. In addition, the Contractor shall observe and record any occurrences of water in the tunnel. The record shall be provided to the Engineer on a daily basis.

3.03 DEWATERING TRENCH

A. No pipeline shall be laid in a trench in the presence of water. All water shall be removed from the trench sufficiently ahead of the pipeline placing operation. The Contractor shall ensure dewatering of the trench to ensure a dry, firm bed on which to place the pipeline. As a minimum, water levels shall be maintained at least 2 feet below the pipe invert. Trench shall continue to be dewatered until trench backfilling operations have been completed.

B. Removal of water may be accomplished by pumping or pumping in connection with well point installation as the particular situation may warrant.

C. If the soils encountered at the trench grade are suitable for the passage of water, without destroying the sides or utility foundation of the trench, sumps may be provided at intervals at the side of the main trench excavation. Pumps shall be used to lower the water level by taking their suction from said sumps.

D. *In cohesive soils where seepage is usually low, groundwater is generally managed by collection in trench bottom sumps for pumped disposal. Care should be taken to have a redundant pumping system that allows for overnight pumping. Water must not be allowed to pond in the trench bottoms.*

E. *Recommend a pre-construction survey of nearby structures be performed prior to construction.*

3.04 REQUIREMENTS FOR EDUCTOR, WELL POINTS, OR DEEP WELLS

A. Install sufficient piezometers or monitoring wells to show that trench or shaft excavations in water bearing materials are pre-drained prior to excavation. Provide separate piezometers for monitoring of dewatering and for monitoring of depressurization. Install piezometers and monitoring wells for tunneling as appropriate for selected method of work.

B. Install piezometers or monitoring wells at least one week in advance of the start of associated excavation.

C. Dewatering may be omitted for portions of under drains or other excavations, where auger borings and piezometers or monitoring wells show that soil is pre-drained by existing systems and that ground water control plan criteria are satisfied.

D. Replace installations that produce noticable amounts of sediments after development.

E. Provide additional ground water control installations, or change method of control if, ground water control plan does not provide satisfactory results based on the performance criteria defined by plan and by the Contract Documents. Submit revised plan according to Paragraph 1.06 B.

3.05 DISPOSAL OF WATER

A. All water removed from the construction site(s) shall be discharged through pipes. The conveying of water in open ditches or trenches will not be allowed. Do not discharge pumped drainage water into the sanitary sewer system or inhibit pedestrian or vehicular traffic with the ground water control system.

B. The Contractor shall secure all applicable permits for groundwater discharged to storm water system that drain directly to waterways.

C. Appropriate extraction well design and construction, settling basins, filter fabric structures, or other means may be used to reduce the concentration of suspended solids to allowable limits, prior to discharge. Discharge from settling basins, if used by the Contractor, shall not cause siltation or flooding in any stream, storm sewer, or on adjacent properties. Settling basins, if used by the Contractor, shall be cleaned of solids as necessary to maintain their efficiency.

D. Permission to use any storm sewers or drains for water disposal purpose shall be obtained from SAWS. All requirements and costs for such use shall be the responsibility of the Contractor. The Contractor shall not cause flooding by overloading or blocking the flow in the drainage facilities, and it shall leave the facilities unrestricted and as clean as originally found.

E. Dewatering effluent shall be managed in a manner that prevents releasing hazardous substances to surface or subsurface soil or groundwater.

F. *Discharge of pumped surface water to the ground surface around the work sites is not permitted.*

3.06 WELL ABANDONMENT

A. Upon completion of the Contract, Contractor shall abandon all existing and new observation wells and piezometers in accordance with TCEQ rules and regulations. The well and piezometer vaults and well covers shall be removed completely and disposed of and the surface restored to preconstruction conditions.

B. Surface restoration in paved areas shall match existing material types and thicknesses as necessary to restore the surface to its original condition. In other areas, restore ground surface by backfilling with topsoil, sod, or other materials as required to match original conditions.

3.07 MAINTENANCE AND OBSERVATION

A. Maintenance and observation of piezometers or observation well is the responsibility of the Contractor an shall consist of keeping them in good condition and observing and recording the elevation of the water level daily, as long as the dewatering system is in operation, and weekly thereafter until the work is completed or the piezometers or wells are removed.

B. Submit a record of the water level to SAWS and the Engineer weekly, as well as with monthly pay applications.

C. Replace damaged and destroyed piezometers or obersvation wells, unless otherwise accepted by SAWS and the Engineer, with new piezometers or wells within 48 hours, at no additional cost to SAWS.

D. Cut off piezometers or observation wells in excavation areas, where exposed, as excavation proceeds, and continue to maintain and make observations in other wells as specified.

E. Remove backfill or grout piezometers or observation wells inside or outside the excavation area, following backfill of trenching or tunnel grouting as approved by SAWS and the Engineer.

3.08 REPAIR OF DAMAGE

A. Contractor to assume full responsibility for all loss and damage due to flooding, rising water, or seepage resulting from dewatering operations in any part of the work. Contractor to repair any damage to partially completed work from these or other causes, and performance of any other work necessitated by lack of adequate dewatering or drainage facilities.

PART 4 - PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. This item is considered subsidiary to the work and no separate payment will be made to the Contractor for the work.

END OF SECTION

PART 1 – GENERAL

1.01 SECTION INCLUDES

Furnishing and placing of grout into the annular space between steel casing pipe installed by trenchless methods and the sanitary sewer pipe, and in the existing sewer mains to be abandoned that are 15-inches or greater in diameter.

1.02 REFERENCES

ASTM C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens)
ASTM C 138	Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
ASTM C 144	Standard Specification for Masonry Mortar
ASTM C 150	Standard Specification for Portland Cement
ASTM C 403	Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C 495	Test Method for Compressive Strength of Lightweight Insulating Concrete
ASTM C 618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
CRD C 621	Specification for Non-shrink Grout

1.03 SUBMITTALS

A. At least 30 days prior to grouting, submit information on equipment, grout mixes and procedures in accordance with the Contract Documents. Shop drawings and product data shall include but not be limited to the following:

1. Detailed descriptions of equipment and operational procedures to accomplish the annular grouting operation, including mixing and pumping schedule, grouting pressures, rates of pumping, and methods for monitoring the effectiveness of the grouting.

2. Detailed descriptions and drawings indicating proposed locations, of surface mixing equipment, subsurface injection points, flow lines, waste grout recovery, grout pressure limiting equipment, bulkheads, and venting system. Show details of bulkhead design.

3. Grout mix design and trial mix tests, with set time, compressive strength and density test results.

4. Submit anticipated volumes of grout to be pumped for each application and reach grouted. Submit details of each grouting stage if multiple lifts are required to avoid flotation of the pipe or collapse of the foam structure of the grout mix.

5. Submit buoyant force calculations for the carrier pipe during grouting and measures to prevent flotation.

6. Contractor's grouting plan shall include a description of methods and devices to prevent buckling of carrier pipe during grouting of annular space.

7. Qualifications and experience of grout mix applicator.

B. During pressure grouting operations, maintain and submit daily logs of grouting operations including pressure, grout volume pumped, and such other data as may be required by the Engineer.

1.04 PERFORMANCE REQUIREMENTS

A. Design grout mix to be pumped through a 2-inch-diameter hose for a distance of 2,000 feet, with a maximum allowable pressure at point of placement of 5 psi. The cast density shall be 55 pcf plus or minus 5 pcf. Minimum penetration resistance after 24 hours shall be 100 psi in accordance with ASTM C 403. The minimum compressive strength at 28 days shall be 200 psi in accordance with ASTM C 495. Grout mix shall have less than 1 percent shrinkage by volume.

B. Provide adequate retardation, to completely fill the annular space in accordance with the Contractor's submitted grouting procedures.

C. The Contractor shall grout the annular space in stages if necessary to prevent damage to the carrier pipe or collapse of the foam structure of the LDCG mix.

D. The application system shall have sufficient gauges, monitoring devices and tests to determine the efficiency and effectiveness of the grouting work and provide a means of accurately determining the amount of grout injected. Contractor shall be prepared to modify the operation should grouting not perform as proposed. Such modifications and changes shall be done in a timely manner to avoid unnecessary delay in completion of the Project.

E. No deleterious amounts of toxic or other poisonous substances shall be included in the grout mix nor otherwise injected underground.

PART 2 – PRODUCTS

2.01 MANUFACTURER/APPLICATORS

The applicator of the grout mix shall be certified by the grout mix manufacturer and approved by the Engineer. The certified applicator shall be regularly engaged in the placement of grout, including completion of pipeline grouting installations having at least 1000 cubic yards in the past 3 years.

2.02 MATERIALS

A. Cement: Comply with ASTM C 150. Pozzolans and other cementitious materials are permitted.

B. Fly Ash: Comply with ASTM C 618; either Type C or Type F shall be used.

C. Sand, if provided, shall conform to ASTM C 144, except as modified below:

U.S. Standard Sieve Size	Percent Passing by Weight
No. 16	100
No. 30	60 – 85
No. 50	10 – 35
No. 100	05 – 25
No. 200	00 – 10

D. Water: Use potable water free from deleterious amounts of alkali, acid, and organic materials which would adversely affect the setting time or strength of the sliplining grout.

E. Admixtures:Admixtures shall be selected by the sliplining grout manufacturer to meet performance requirements, improve pumpability, control set time and reduce segregation.

F. Low Density Cellular Grout Fill

1. To be manufactured at jobsite by mixing cement-sand slurry with a preformed foam. A foam generator will be used to produce the foam by mixing the concentrate with water and compressed air through a foam-making nozzle. The foam is then injected into the mixer and blended with the cement-sand slurry to produce the low-density cellular grout which has high flowability and pumpability to permit filling of voids. Except where otherwise specified, use one-part cement, three parts sand, and four parts foam, by volume, complying with the following:

   a. Cement: ASTM C-150, Type I or Type II.

   b. Sand: ASTM C-33.

   c. Foam Concentrate: ASTM C-869.

PART 3 – EXECUTION

3.01 PREPARATION

A. Notify SAWS at least 24 hours in advance of grouting operations.

B. Select and operate grouting equipment and carry out procedures with sufficient safety and care to avoid damage to existing underground utilities and structures.

3.02 EQUIPMENT

A. Mixers and Pumps: System shall mix the grout to a homogeneous consistency. Deliver grout to the injection point at a steady pressure with a non-pulsating centrifugal or triplex pump at the mix tank. Provide ways to increase or decrease the water-cement ratio and accurately measure grout component quantities, pumping pressures, and volumes pumped.

B. Pressure Gauges:

1. Pressure gauges shall be equipped with diaphragm seals, have a working range between 1.5 to 2.0 times the design grout pressure and have an accuracy within 0.5 percent of full range.

2. Provide one pressure gauge at the point of injection and one pressure gauge at the grout pump.

3. Grouting shall not proceed without appropriate gauges in place and in working order.

3.03 GROUTING

A. Place grout in the existing pipe where indicated in project plans. Completely fill the annular space without deflecting the pipe. Test grout equipment and procedures in accordance with approved submittals. Perform testing on the first pipeline segment to be grouted; testing must be performed under observation by SAWS. If the grout does not totally fill the pipeline, adjust the procedure or the mix, and rerun the test on the first pipeline segment.

1. Mixing of Grout: The material shall be mixed in equipment of sufficient size to provide the desired amount of grout material for each stage in a single operation.

2. Grout temperature to be monitored and recorded at the following increments: At pour, and at 4 hours, 8 hours and 24 hours after pour.

3. Backfill Annular Space with Grout: After the installation of the carrier pipe, the remaining space (all voids) between the casing and the carrier shall be filled with LDCG so all surfaces of the exterior carrier pipe wall and casing interior are in contact with the grout.

4. Once grouting operations begin, grouting shall proceed uninterrupted, unless grouting procedures require multiple stages. Grout placements shall not be terminated until the estimated annular volume of grout has been injected.

5. Place grout for a given pipeline segment between bulkheads. Place bulkheads at the ends of each pipeline segment to seal from sewer flow. Do not remove bulkheads until after grout has set.

6. Remove or control standing or running water in annular spaces to maintain the correct water ratio of the grout mixture. Grout the annular space by injecting grout from one end of the pipeline segment, allowing it to flow toward the other end.

7. Limit pressure on the annular space to prevent damage to the pipe; do not exceed 5 psi. Regardless of the pressure, Contractor shall be solely responsible for any damage or distortion to carrier pipe due to grouting. At the bulkhead opposite to the point of grouting, provide and monitor an open-ended high point tap or equivalent vent.

8. Pump grout until grout within 0.3 pounds per gallon of specified grout injection density discharges from the end opposite the injection point. This procedure is intended to ensure that the grout is not diluted by extraneous water.

9. The drilling of additional injection holes from the surface to facilitate grouting may be allowed if approved by SAWS.

3.04 DEWATERING SYSTEM OPERATION

A. Operate dewatering systems until the grouting of carrier pipe is complete.

3.05 TESTING

A. Density: During placement of grout, measure density in accordance with ASTM C 138 at least twice per hour. Adjust the mix as required to obtain the specified cast density.

B. Sampling:

1. Take 4 test specimens for each 500 cubic yards of grout, or for each 4 hours of placing.

2. Test in accordance with ASTM C 495 except:

a. Specimens shall be 3-inch by 6-inch cylinders covered after casting to prevent damage and loss of moisture. Moist-cure specimens for at least the first 7 days; perform at least one compressive strength test of each set of samples at 28 days.

b. Do not over-dry specimens to be tested. Specimens may be tested at any age to monitor compressive strength. The material may require special handling and testing techniques.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. This item is considered subsidiary to the work and no separate payment will be made to the Contractor for the work.

END OF SECTION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This section is intended to supplement SAWS Item 856 – Jacking, Boring or Tunneling Pipe. No modifications to Item 856 are proposed.

B. This section covers work necessary to control groundwater, surface water, runoff, and nuisance water that may be encountered, as required for performance of the trenchless work.

C. This Section covers the control and disposal of water that may enter shaft and tunnel excavations. In areas where lowering of existing groundwater is necessary for completing shaft and tunneling work, such dewatering shall be completed in accordance with SAWS Item 804 – Excavation, Trenching and Backfill, as well as provisions of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02400 – Tunnel Shafts

B. SS 02314 – Tunneling with Steel Liner Plate

C. SS 02341 – Pipe-Jacked Tunnels

D. SAWS 804 – Excavation, Trenching, and Backfill

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code or standard occur, the more restrictive specification shall govern. The publications are referenced in the text by basic designation only. Where a date is given for referenced standards, that edition shall be used. Where no date is given for referenced standards, the latest edition available on the date of issue of Contract Documents shall be used.

B. San Antonio Water System (SAWS)

1. Specifications for Water and Sanitary Sewer Construction – latest version

2. Materials Specifications

1.04 DEFINITIONS – Not Used

1.05 DESIGN CRITERIA

A. Provide continuous control of surface water runoff and water in shafts and tunnels at all times during the course of construction, including weekends and holidays, and during periods of work stoppages.

B. Design, furnish, install, operate, and maintain all machinery, appliances, power, and equipment necessary to remove water from tunnels and shafts during construction. Dewater, treat, and dispose of water so as not to cause injury to public or private property or to cause a nuisance or a menace to the public and in accordance with all applicable permit requirements.

C. Have on hand at all times sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, including power outages and flooding, and have available at all times competent workers for the continuous and successful operation of the water control and monitoring systems.

D. The Contractor shall obtain all permits and other documentation necessary to properly treat (where required), discharge or dispose of collected water.

E. Remove all dewatering equipment when construction is completed.

1.06 QUALITY ASSURANCE – Not Used

1.07 SUBMITTALS

A. Submittals shall be made in accordance with SAWS's requirements. Review and acceptance of the Contractor's submittals by the Consultant shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

B. Control of Ground and Surface Water Plan: Submit methods and equipment proposed to be utilized to prevent excessive groundwater from entering shafts and tunnels, and to remove and dispose of the water that does enter.

C. Submit drawings indicating location and configuration of water control facilities including, but not limited to, water control barriers, monitor wells, sumps, discharge lines, storage tanks or basins, and discharge points or disposal methods.

D. Submit detailed description of water control schedule, operation, maintenance, and abandonment procedures.

E. Submit drawings and details of any required treatment facilities to be used in treating water that collects within the shafts.

F. Submit a copy of all applicable permits required for discharge of collected water or documentation of proper offsite disposal plans. Confirm that disposal plan is in compliance with all permit requirements.

PART 2 – PRODUCTS – Not Used

PART 3 – EXECUTION

3.01 GENERAL

A. Modify water control system after installation and while in operation if it causes or threatens to cause damage to adjacent property or to existing buildings, structures, or utilities.

B. Take reasonable precautions necessary to ensure successful operation of water control systems.

C. Dispose of water under terms, requirements, and restrictions of applicable permits.

3.02 SURFACE DRAINAGE

A. Intercept and divert surface drainage away from the work by use of dikes, curb walls, ditches, sumps, or other means, in accordance with the approved plan.

B. Design surface drainage system so as not to cause erosion on or off the site and to prevent impacts to the water quality of existing surface water. Surface runoff shall be controlled to prevent entry of water into excavations and shafts, water bodies, sanitary, or storm sewers, unless written permission is provided by the facility Owner allowing discharge.

3.03 WATER CONTROL IN UNDERGROUND WORKS

A. Use water control methods that are appropriate to the ground conditions, described in the Geotechnical Data Report, the planned construction operations, and requirements of these Contract Documents.

B. If a large amount of subsurface water drains into an excavation, take immediate steps to control water inflow. Large amounts of inflow requiring immediate control shall be defined as that which adversely affects the work and/or threatens damage to adjacent structures or facilities.

C. Design and operate water control system to prevent removal of in situ soils or loosening or softening of in situ soils surrounding the excavation.

D. Water shall be removed during periods when concrete is being placed, during tunneling operations, when pipe is being installed, during shaft excavation, and at such other times as is necessary for efficient and safe execution of the work.

E. If a concrete tremie plug or work slab for shaft construction is required, the plug shall not be subjected to unbalanced hydrostatic pressures until it has obtained compressive strength sufficient to resist uplift pressure.

3.04 TREATMENT AND DISPOSAL OF WATER

A. Obtain necessary permits from the authority having jurisdiction to use any sanitary sewers, storm sewers, drains, or waterways for water disposal purposes.

B. Discharge water removed from the site through pipes, tanks, or by truck and as required by the Contractor's discharge permit. Water shall be discharged in a manner that will not cause soil erosion at discharge point.

C. Treat water collected in shafts as required by regulatory agencies prior to discharge.

3.05 SYSTEM REMOVAL

A. Facilities shall be removed and wells abandoned at the completion of the work in conformance with regulatory requirements and Contractor's permit.

PART 4 – PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. This item is considered subsidiary to the work and no separate payment will be made to the Contractor for the work.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the minimum requirements for the installation of temporary tunnel support using a tunneling shield and steel liner plate, for the subsequent installation of gravity sewer pipe at the locations shown on the Contract Documents. Carrier pipe shall be provided in accordance with the applicable Specification Section and installed in accordance with Section SS 02426 – Carrier Pipe in Tunnels. The Contractor shall furnish all labor, equipment, power, and materials necessary for tunneling, spoil removal and disposal, tunnel support installation, contact grouting behind tunnel supports, and other associated Work.

B. A tunneling shield is required at all locations where liner plate tunnel is allowed, unless specifically noted otherwise on the Contract Documents. In certain locations only non-rotary shields are allowed due to anticipated mix-face conditions. See the Drawings for locations where only non-rotary shields are allowed.

C. Certain locations require lowering of existing groundwater to below the tunnel invert elevation prior to tunneling work. Perform all dewatering work in accordance with SAWS and Section SPST 804 – Excavation, Trenching, and Backfill, Section SS 02140 – Control of Ground and Surface Water, and Section SS 02242 – Water Control for Shaft Tunnel Construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SAWS and Section SPTS 804 – Excavation, Trenching, and Backfill

B. Section SS 02218 – Low Density Cellular Grout Fill

C. Section SS 02140 – Control of Ground and Surface Water

D. Section SS 02242 – Water Control for Shaft Tunnel Construction

E. Section SS 02400 – Tunnel Shafts

F. Section SS 02315 – Portal Stabilization

G. Section SS 02441 – Pipe-Jacked Tunnels

H. Section SS 02426 – Carrier Pipe in Tunnels

I. Section SS 02445 – Settlement Instrumentation and Monitoring

J. Section SS 03360 – Contact Grouting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code, or standard occur, the more restrictive specification shall govern. The publications are referenced in the text by basic designation only. Where a date is given for referenced standards, that edition shall be used. Where no date is given for referenced standards, the latest edition available on the date of issue of Contract Documents shall be used.

1. San Antonio Water System (SAWS)

    a. Specifications for Water and Sanitary Sewer Construction – latest version

2. Commercial Standards:

    a. AASHTO HB-17 “Standard Specifications for Highway Bridges”, Section 15

    b. ASTM A-36: “Structural Steel”

    c. ASTM A-123: “Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products”

    d. ASTM A-153: “Zinc Coating (Hot Dip) on Iron and Steel Hardware”

    e. ASTM A-307: “Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength”

    f. ASTM A-449: “Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use”

    g. ASTM A-1011: “Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength”

3. Safety Codes:

    a. Occupational Safety and Health Administration (OSHA) Regulations, 29 CFR Part 1926 Subpart P – Excavations, and Subpart S – Underground Construction.

4. Geotechnical Reports:

    a. “Geotechnical Investigation Design Report: SAWS E-4 Sanitary Sewer Line – San Antonio, Texas”, HVJ Associates, December 10, 2019.

1.04 DEFINITIONS

A. Carrier Pipe: Permanent pipe for operational use that is used to convey flows. Carrier pipes may be installed inside a casing pipe or liner plate tunnel.

B. Grout Port: A port located within the primary tunnel liner segments for injection of contact grout into the annular space between the excavated ground and the primary tunnel liner. Grout ports with the liner are threaded to accept grout fittings and plugs, to be inserted once grouting is complete.

C. Open-Shield Tunneling: Open-shield tunneling is a technique for installing a primary tunnel liner between a launch shaft, and a receiving shaft, where face of heading or tunnel is unsupported during excavation. Soil/rock excavation is carried out within a tunneling shield or TBM at the front of the tunnel excavation, using hand mining or mechanical methods such as a rotary TBM, roadheader, or digger-boom. The excavation method should be chosen to be compatible with the anticipated ground conditions. The shield is steerable using hydraulic or mechanical jacks to orient an articulated section, and guidance is provided using a laser or theodolite system. The shield has a tail section that allows for the safe erection of the primary tunnel liner, and a propulsion system that advances the shield by pushing against the previously installed tunnel liner section.

D. Primary Tunnel Liner: Elements designed, fabricated, furnished, installed, monitored, and maintained in the tunnel by the Contractor for initial ground support to provide excavation stability and safety during construction. The primary liner provides temporary ground support to allow for the installation of the final gravity sewer pipe and annular space grout which serve as the final lining system.

E. Tunnel Boring Machine (TBM): Mechanized and fully shield excavation equipment that is articulated and steerable, guided, and with man entry.

F. Tunneling Work Plan: A written description, together with supporting documentation, that defines the Contractor’s plans and procedures for the tunneling operations.

G. Tunneling Shield: Fabricated ground support, circular in section, providing a 360-degree protection to those working within it. The tunneling shield has a cutting edge, and is equipped with independently operated hydraulic propulsion rams, allowing it to be steered. The shield typically has a hood protrusion at the crown (except in the case of a rotary TBM), and face breasting equipment. Liner plate is erected within a tail attached to the back of the shield. The shield is propelled forward by pushing against the previously installed primary tunnel liner.

1.05 DESIGN CRITERIA

A. Tunnel Liner Plate:

1. The liner plate tunnel support system shall be designed by a Professional Engineer engaged by the Contractor, who is licensed in the State of Texas.

2. Design Tunnel Liner Plate in accordance with the methods and criteria as specified in AASHTO HB-17.

3. Design of the liner plate shall account for all installation and service loads including: external groundwater and earth loads; applicable live loads (H-20, E-80, etc.); practical

consideration for shipping, handling, installation, contact grouting, and other construction operations; loads imposed by the tunnel shield or TBM thrust jacks; any other live or dead loads reasonably anticipated.

4. Soil parameters used for liner plate design shall be consistent with the ground conditions described in the Geotechnical Data Report, and the conditions anticipated by the Contractor.

5. Thickness of liner plates shall be sufficient to support the dead and live loads above and around the tunnel with allowable deflections not to exceed three (3%) percent of the nominal OD at any point measured diametrically.

6. The minimum thickness gauge, joint strength, and wall buckling strength shall meet or exceed the values tabulated in Section 2, which are calculated by the design methods of AASHTO HB- 17. The Contractor may provide either 2-flange continuous corrugation plates, or 4-flange partial corrugation plates.

7. The design and shape of liner plates shall be such that erection and assembly can be accomplished entirely from inside the tunnel shield.

8. A sufficient number of liner plate segments shall be provided with grout ports for contact grouting between the liner and the surrounding ground. Grout ports shall be a minimum of 2 inches in diameter. Ports and fittings shall be located generally in the center of plate sections and attached to the liner plate in a manner that will not materially affect the strength of the system nor interfere with installation of carrier pipe. Threaded plugs for sealing the fittings shall be provided by the Contractor and shall be capable of withstanding all external and internal pressures and loads without leaking.

9. Liner plates with grout ports shall be installed such that there will be one line of ports on each side of the tunnel below spring-line, and one line at the crown; the elevation of the lower line of ports on each side shall be not more than 18 inches above the tunnel invert. The ports in each line shall not be more than 9 feet apart and, unless otherwise approved, shall be staggered evenly.

10. Liner plate shall be provided with clear inside diameter sufficient to allow efficient installation of the carrier pipe, including required supports and clearances as Specified in 02426 – Carrier Pipe in Tunnels, and as necessary for the Contractor's planned means and methods. Determination of the primary tunnel liner size and section shall be the sole responsibility of the Contractor, to match methods and equipment described in the submitted Tunneling Work Plan.

11. For gravity sewer carrier pipe installations where the annular space will be completely filled with grout, galvanized or coated liner plates and galvanized hardware are not required.

B. Tunnel Shield:

1. The Contractor shall conduct all tunnel excavation work from within a shield that provides adequate protection for workers.

    a. In certain locations specifically called out on the Contract Documents the shield requirement may be waived if stable ground conditions are anticipated. See the Contract Documents for locations where a tunnel shield is not required.

2. The Contractor shall be responsible for selection of tunneling equipment which, based on the past experience, has proven to be satisfactory for excavation and support of the ground conditions described in the Geotechnical Data Report, and the conditions anticipated by the Contractor. The tunneling equipment shall be capable of handling the various ground conditions anticipated and shall minimize loss of ground ahead of the face.

3. The shield shall be designed to support all ground loads which may be imposed upon it, as well any loads imposed by the thrust jacks, steering mechanisms, or other appurtenances.

4. The tunneling shield or TBM shall conform to the shape of the tunnel with a uniform perimeter that is free of projections that could produce over-excavation or voids.

5. The tunneling shield shall be capable of full-face closure or shall permit ready installation of breasting boards, sand shelves, or closeable flood doors, and shall be designed to handle adverse ground conditions including groundwater ingress. The upper half of the tunnel heading shall be supported whenever ground conditions indicate potential raveling of the crown. The tunnel heading shall be completely closed off whenever tunneling work is not being performed.

6. Non-rotary type shields shall have hood that covers crown and projects not less than two (2) feet beyond shield.

7. If a rotary-type TBM is used, the cutterhead shall have a reversible drive system so that it can rotate in either direction or have other suitable provisions to minimize rotation or roll of the shield during operation.

8. The tunneling shield shall include the capability to efficiently excavate and operate in competent full-face rock conditions, as may be encountered along the tunnel reaches. In certain locations a rotary TBM is not considered appropriate due to anticipate mixed-face conditions of soft ground overlying bedrock and is therefore not allowed for certain reaches.

9. The tunneling shield shall maintain the face of the excavation to allow the minimum of void space outside the liner plate.

    a. Maintain a maximum of 1/2" radial overcut between the outside of the shield O.D. and the excavation.

b. In no case shall the excavated tunnel diameter be greater than 4" larger than the tunnel liner O.D., or greater than that recommended by the liner plate manufacturer.

10. The shield shall be capable of full directional guidance, shall be equipped with visual display to show the operator actual position of the shield relative to the design line and grade reference, and shall be capable of correcting roll. The Contractor shall control the drift of any heading to maintain design line and grade.

11. The guidance system used for tunneling work shall be designed to function at the maximum required drive length without loss of accuracy or reliability of function.

12. The tunneling shield shall have a tail section long enough to enable installation of liner plate rings within the shield, while still providing at least 12 inches of overlap beyond the last installed support elements when the thrusting jacks are at maximum extension.

13. The tunneling shield shall have a propulsion system capable of steering and moving the shield forward while maintaining the construction tolerances with respect to line and grade. The propulsion system shall include a thrust ring or other provision for distributing the jacking forces uniformly around the tunnel perimeter to avoid damaging or distorting the tunnel liner. The propulsion system shall be designed so that in the event of failure of any element of the system there will be no backward movement and no overstressing or distortion of the tunnel liner.

14. The spoil conveyance system shall be designed for the full range of ground conditions as described in the Geotechnical Data Report, and as anticipated by the Contractor.

C. Methods and equipment used shall control surface settlement and heave above the tunnel to prevent damage to existing utilities, facilities, and improvements. Any ground movements (settlement/heave) shall be limited to values that shall not cause damage to adjacent utilities and facilities. In no case shall settlements exceed the applicable values listed in Section 02445, Settlement Monitoring. The Contractor shall repair any damage caused by ground movements at no cost to SAWS.

D. All space between the tunnel liner and the surrounding ground shall be filled with grout forced under low pressure. Grouting shall closely follow the liner plate installation, since it is extremely important that firm contact exist between the liner plates and surrounding ground. At a minimum, contact grouting shall take place once per working shift to backfill the annular space between all liner sections outside of the tunnel shield. If necessary, grout stops shall be placed at the end of the lining to permit grouting to or near the forward end of the erected liner plate tunnel.

E. A secondary liner shall be required with this system. The secondary liner will be the FRP gravity sewer carrier pipe combined with low density cellular grout in the annular space.

F. The tunnel excavations shall begin at the approximate locations shown on the Drawings, or as approved in writing by the designed SAWS' Representative.

G. Shaft excavations for liner plate tunneling operations shall only be located in the approximate areas shown on the Drawings. Additional shaft excavations, or alternate shaft locations shall only be allowed with the written approval of SAWS' Representative.

1.06 QUALITY ASSURANCE

A. Failure to meet the qualification requirements is failure to fulfill the Contract and the Contractor will be required to obtain a subcontractor that meets the qualification requirements.

B. All tunneling work shall be performed by an experienced Contractor who has at least five (5) years of experience in performing tunneling work using liner plate support and has completed at least five (5) projects of similar diameter in similar ground conditions.

1. At least one individual tunneled length shall have been equal to or greater in length than the longest tunnel on this Project.

2. At least one tunnel shall have been completed in full-face rock conditions.

3. At least one tunnel shall have been completed in mixed-face conditions of soil overlying bedrock.

4. At least two tunnels shall have been completed using a shield to support the ground at the tunnel face.

5. The Contractor shall submit details of referenced projects including SAWS's name and contact information, and project superintendent.

C. The project superintendent shall have at least five (5) years of experience supervising tunneling construction using liner plate support. The Contractor shall submit details of referenced projects including SAWS' name and contact information, and project superintendent.

D. All contractor personnel who will work within the shaft excavations or within the tunnel shall have completed training in excavation safety and confined space work.

E. The site safety representative and personnel responsible for air quality monitoring shall be experienced in tunnel construction and shall have current certification by OSHA.

F. The surveyor responsible for line-and-grade control shall be a Licensed Surveyor registered in the State of Texas who has prior experience on tunnel projects.

G. The Contractor shall provide written notice to SAWS at least 72 hours in advance of the planned launch of tunneling operations. All Work by the Contractor shall be done in the presence of SAWS unless SAWS grants prior written approval to perform such Work in SAWS's absence.

H. The Contractor shall allow access to SAWS' Representative and shall furnish necessary assistance and cooperation to aid SAWS' Representative in observations, measurements, data, and sample collection, including, but not limited to the following:

1. SAWS' Representative shall have full access to the tunnel and shield prior to, during, and following all tunneling operations. This shall include, but not be limited to, visual inspection of installed pipes and verification of line and grade.

2. SAWS' Representative shall have full access to the tunneling shafts prior to, during, and following all tunneling operations. The Contractor shall provide safe access in accordance with all safety regulations.

3. SAWS' Representative shall have full access to spoils removed from the tunnel excavation prior to, during, and following all tunneling operations. SAWS shall be allowed to collect soil samples from the muck buckets or spoil piles a minimum of once every ten (10) feet, whichever is more often, and at any time when changes in soil conditions or obstructions are apparent or suspected.

1.07 SUBMITTALS

A. Submittals shall be made in accordance with SAWS' requirements. Review and acceptance of the Contractor's submittals by SAWS' Representative shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

B. Qualifications: Submit the name of the contractor or subcontractor that will perform the tunneling Work and written documentation summarizing the qualifications of the firm, description of reference projects including SAWS' name and contact information, project superintendent, and site safety representative. Submit personnel qualifications in accordance with Paragraphs 1.06 B through F. Provide qualifications and training records for site safety representative, personnel responsible for air quality monitoring, and licensed surveyor.

C. Work Area Layout Drawings: The Contractor shall submit shaft work area layout drawings detailing dimensions and locations of all equipment, including overall work area boundaries, crane, front-end loader, forklift, spoil stockpiles, spoil hauling equipment, pumps, generator, pipe storage area, tool trailer or containers, fences, and staging area. Shaft layout drawings will be required for all shaft locations and shall be to scale, or show correct dimensions. The Contractor's layout drawings shall show that all equipment and operations shall be completely contained within the allowable construction zones shown on the Drawings.

D. Tunneling Work Plan:

1. Submit a detailed description of the methods and equipment to be used in completing each tunneled reach.

2. Manufacturer and type of tunneling shield and other equipment to be used: description and details of the shield excavation system, machine controls, steering procedures,

excavation tools, cutter types and arrangement, face breasting or flood door provisions, mucking system, thrust jacks, and liner erection equipment.

3. Submit a description of the alignment control system:

    a. Provide manufacturer's literature and drawings, showing setup and support provisions, and other details for the laser, and/or theodolite system. Confirm that these systems can achieve the required line and grade within the specified tolerances.

    b. Submit a description of surveying methods to set guidance system positions and a description of procedures to check and reset or realign guidance system during construction.

    c. Submit results of line and grade survey to ensure that the floor slab, and launch and retrieval portals are installed properly, prior to launch.

4. Detailed description of equipment and procedures for excavation, spoil removal, containment, transport, and off-site disposal. Provide written documentation from the disposal site(s) indicating that they will accept the spoil and are in compliance with applicable regulations.

5. Ventilation and air quality monitoring system, including monitors and alarm activation.

E. Calculations: Calculations shall be submitted in a neat, legible format. Basis of calculations shall be consistent with the ground conditions described in the Geotechnical Report, and the conditions anticipated by the Contractor. All calculations shall be prepared by or under the direct supervision of a Professional Engineer licensed in the State of Texas, who shall stamp and sign the calculations.

1. Submit design drawings and calculations for the design of the tunnel liner plate confirming that liner plate capacity is adequate to safely support all anticipated loads, including earth and groundwater pressures, any applicable traffic loads or other live loads, surcharge loads, grouting pressures, and handling loads. Submitted drawings shall be adequate for construction and include installation details.

F. Tunnel Liner Plate Product Data: Submit shop drawings and other product data for tunnel liner plate sections and fasteners. Include information on any coatings, if required.

G. Liner Plate Contact Grouting Plan:

1. A description of liner plate contact grouting methods and equipment that includes sketches as appropriate, indicating type and location of mixing equipment, pumps, injection ports, pressure measurement and maximum allowable pressure, blocking or otherwise securing liner to avoid excessive displacement, volume measurement, grouting sequence, schedule, and stage volumes. Include planned grout port locations and spacing.

2. A grout mix design including: grout mix constituents and proportions, including materials by weight and volume; grout densities and viscosities, including wet density at point of placement and initial set time of the grout; and compressive strength.

H. Schedule: Provide a schedule for all tunneling work, identifying all major construction activities as independent items. The schedule shall include, at a minimum, the following activities: mobilization, shaft excavation and support, working slab construction, tunneling, liner plate installation and contact grouting, installation of carrier pipe, shaft backfill, site restoration, cleanup, and demobilization. The schedule shall also include the work hours and workdays for each activity, and a written description of the construction activities. The schedule will be reviewed by SAWS' Representative and shall be updated and resubmitted by the Contractor every two (2) weeks or more frequently if requested by SAWS' Representative.

I. Daily Records: The following daily records shall be submitted to the onsite SAWS' Representative for review, by noon on the day following the shift for which the data or records were taken:

1. Tunneling Records: The Contractor shall provide complete written tunneling records to SAWS' Representative. These records shall include, at a minimum: date, time, name of superintendent, tunnel drive identification, installed liner plate ring number and corresponding tunnel length, time required to excavate each segment, time required to set subsequent liner plate ring, spoil volumes (for example: muck carts per pipe segment and estimated volume per cart), soil conditions (including occurrences of unstable soils/rock and any corresponding ground loss) and groundwater inflow rates (if any), line and grade offsets, any movement of the guidance system, problems encountered with tunnel components or equipment, any observed deformations of the primary liner, and durations and reasons for delays.

2. Grouting Records: Maintain daily logs of grouting operations and submit records of grouting to SAWS' Representative. The records shall include the following information: time and date, name of the grouting supervisor, tunnel station, liner ring number and port number, grout mix, grout volume pumped and pumping pressures, observations of any liner deformations, interruptions, leakages, or other grouting issues.

3. Manually recorded observations shall be made at intervals of not less than one time per liner plate ring, as conditions change, and as directed by SAWS' Representative.

4. At least seven (7) days prior to the launch of the shield, the Contractor shall submit samples of the jacking logs or records to be used.

J. Contingency Plans: The following list includes possible problem scenarios that may be encountered during the tunneling operations (the list is not all-inclusive of issues that could arise during construction). The Contractor shall submit contingency plans for dealing with each scenario while satisfying the Specifications. These plans shall include the observations and measurements required to clearly identify the cause of the problems.

1. Hydrocarbon smell is detected in the shield or in the shaft.

2. Settlement and Subsidence:

   a. Survey measurements indicate deformations exceed allowable limits.

   b. Excavated volumes significantly exceed pipe volume installed.

   c. Voids are encountered or created by over excavation that may not be detectable by survey measurements.

3. Severe storms or flooding predicted; shaft flooding possible.

4. Groundwater inflows into the tunnel which may carry soil into the tunnel and lead to voids outside the tunnel liner, or that may pose a hazard to workers.

K. Tunnel Shield Maintenance Plan:

1. The Maintenance Plan shall include, but not be limited to: tunneling shield/TBM, ground support installation equipment, muck handling equipment, lighting and ventilation equipment, safety equipment, and all other items determined to be essential for safe, efficient tunneling.

2. The Plan shall also include procedures for in-place replacement of tunneling shield/TBM components (e.g. cutting tools) when the tunnel excavation efficiency is reduced to the extent that completion of the work on schedule is jeopardized.

3. Include details and drawings to describe means and methods for gaining access to the cutterhead/cutting tools if required, including:

   a. Step-by-step description of planned cutterhead/cutting tool inspection and/or repair,

   b. Contingency plans and alternative methods.

4. The Maintenance Plan shall be sufficiently detailed to identify all maintenance activities and shall include as a minimum a schedule of required daily, weekly, and monthly procedures.

5. Include a list of replacement parts and maintenance materials that will be stored on site during the Contract Work.

L. Safety Plan: A Safety Plan for the tunneling operations including:

1. Air monitoring equipment and procedures.

2. Provisions for lighting, ventilation, and electrical system safeguards.

3. Protection against soil instability and groundwater inflow.

4. Safety for tunnel and shaft access and exit including ladders, stairs, walkways, and hoists.

5. Protections against mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.

6. Monitoring for hazardous gases.

7. Means for emergency evacuation and self-rescue.

8. Protection of shaft including traffic barriers, accidental, or unauthorized entry, and falling objects.

9. Provide name of site safety representative responsible for implementing safety program.

M. Geotechnical Investigation: When Geotechnical Investigations are conducted by Contractor, submit results to SAWS for Record purposes.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Manufacturers:

1. Contech Construction Products, Inc.

2. DSI Tunneling, LLC.

3. Or pre-approved equal.

B. Tunnel Liner Plate:

1. Corrugated metal tunnel liner plates shall be made from steel sheets conforming to the requirements of ASTM A-1011.

2. If galvanized steel is called for on the Drawings, material to be galvanized shall be zinc coated in accordance with ASTM A-123, except that the zinc shall be applied at a rate of 2.0 oz. per square foot on each side. Bolts and nuts shall be galvanized to conform to ASTM A153. Galvanizing shall not be required for tunnels where the carrier pipe will be fully grouted into place immediately after placement.

3. Steel liner plates may be either 2-flange or 4-flange type, 16 inches to 24 inches in width.

4. Tunnel Liner Plates and fasteners shall comply with the requirements of AASHTO HB-17.

   a. The minimum thickness gauge of liner plates shall meet or exceed the values tabulated below, which are calculated by the design methods of AASHTO HB-17.

TABLE 1: 2 FLANGE LINER PLATE, H-20 LIVE LOAD					
Nominal Diameter		Thickness		Height of Fill	
feet, inches	meters, m	Gauge	mm	feet	meters, m
7’ & less	2.1 m & less	12	2.7	All fill heights	
7’ 2” to 9’	2.15 m to 2.7 m	10	3.4	All fill heights	
9’ 2” to 11’	2.75 m to 3.3 m	8	4.2	All fill heights	

Note: For diameters larger than 11 feet (3.3 meters) or for any diameter with unstable soil conditions, consult the manufacturer.

TABLE 2: 2 FLANGE LINER PLATE, H-20 LIVE LOAD					
Nominal Diameter		Thickness		Height of Fill	
feet, inches	meters, m	Gauge	mm	feet	meters, m
7’ & less	2.1 m & less	10	3.4	All fill heights	
7’ 2” to 9’	2.15 m to 2.7 m	8	4.2	All fill heights	
9’ 2” to 11’	2.75 m to 3.3 m	7	4.6	to 28’	to 8.4 m
9’ 2” to 11’	2.75 m to 3.3 m	5	5.3	over 28’	over 8.4 m

Note: For diameters larger than 11 feet (3.3 meters) or for any diameter with unstable soil conditions, consult the manufacturer.

   b. Liner plates shall be punched for bolting on both longitudinal and circumferential seams and fabricated to permit complete erection from the inside of the tunnel.

   c. Where shown on the Drawings, gasketed liner plates shall be used.

   d. Field welding of Tunnel Liner Plate, including grout couplings shall not be allowed.

   e. The material used for the construction of these plates shall be new, unused and suitable for the purpose intended.

   f. Bolts used with lapped-seam (2-flange) liner plates shall be not less than 5/8” diameter. Bolts shall conform to ASTM A-449 for plate thickness equal to or greater than 0.209”, and to ASTM A-307 for plate thickness less than 0.209”. The nuts shall conform to ASTM A-307.

   g. Bolts used with 4-flange liner plates shall be not less than ½” diameter for plate thickness up to and including 0.179”, and not less than 5/8” diameter for plates of greater thickness. The bolts and nuts shall be quick-acting coarse thread and shall conform to ASTM A-307, Grade A.

h. The following defects are specified as constituting poor workmanship and the presence of any of them in any individual liner plate, or in general in any shipment, shall constitute sufficient cause for rejection:

i. Uneven laps,

ii. Elliptical shaping,

iii. Variation form a straight centerline,

iv. Ragged edges,

v. Loose, unevenly lined or spaced bolt holes,

vi. Illegible brands,

vii. Dents or bends in the metal itself,

viii. Evidence of prior use.

C. Contact Grout for Initial Tunnel Support:

1. Grout used for backfill of the annular space between the tunnel liner plates and the surrounding ground shall be mixed in the volumetric proportions of 1-part Portland cement, 1-part bentonite, and not to exceed 5 parts of sand. Enough water shall be used to produce, when well mixed, a grout having the consistency of thick cream.

2. Contact grout shall have a minimum unconfined compressive strength of 10 psi in 24 hours, and 50 psi in 28 days.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Tunneling shall not begin until the following tasks have been completed:

1. All required submittals have been provided, reviewed, and accepted.

2. The Contractor shall notify the One Call system to request marking of utilities by utility SAWSs/operators that subscribe to One Call and shall individually notify all other known or suspected utilities to request marking of these utilities. The Contractor shall confirm that all requested locates are made prior to commencing tunneling operations. The Contractor shall visually confirm and stake all existing lines, cables, or other underground facilities including exposing all crossing utilities and utilities within ten (10) feet laterally of the designed tunnel. The Contractor shall also contact the San Antonio Water System prior to excavation regarding existing sewer and water utility locations.

3. Shaft excavations and support systems for each drive have been completed in accordance with submittals and the requirements of this Section and Section 02400 – Tunnel Shafts.

4. The Contractor has confirmed that the ground will remain stable without movement of soil or water while the entry/exit location shoring is removed and while the tunnel is being launched or received into a shaft, in accordance with Section 02315 – Portal Stabilization.

5. Existing groundwater has been lowered to an elevation beneath the proposed tunnel invert in locations called on out on the Drawings.

6. Site safety representative has prepared a code of safe practices and an emergency plan in accordance with OSHA and other applicable requirements. Provide SAWS' Representative and SAWS with a copy of each prior to tunneling. Hold safety meetings and provide safety instruction for new employees as required by OSHA. Conduct a pre-construction safety conference in accordance with OSHA requirements.

7. All specified settlement instrumentation has been installed, approved, and baselined in accordance with Section 02445 – Settlement Monitoring.

8. The Contractor has provided written notice of the inception of tunneling operations a minimum of 72 hours prior to start.

9. A start-up inspection of all mechanical and hydraulic systems associated with the tunneling operations has been completed. SAWS' Representative shall be notified at least 72 hours prior to the start-up inspection and SAWS representative shall be present during the inspection. The records of the start-up inspection shall be submitted to SAWS' Representative within 24 hours of the completed inspection.

B. The Contractor shall provide the necessary groundwater control measures to perform the work and to provide safe working conditions. Dewatering operations conducted outside of the shaft excavations or along tunnel alignments shall be conducted in accordance with the dewatering requirements described in SAWS Section SS 804 – Excavation, Trenching, and Backfill, Section SS 02140 – Control of Ground and Surface Water, and Section SS 02242 – Water Control for Shafts and Tunnels.

C. The Contractor shall properly manage and dispose of groundwater inflows to the shafts in accordance with requirements of Section SS 02140 – Control of Ground and Surface Water and Section SS 02242 - Water Control for Shafts and Tunnels, and all permit conditions. The Contractor shall not discharge groundwater inflow into storm sewers, sanitary sewers, water bodies, or streets without proper approval and permits.

D. The Contractor shall furnish all labor, equipment, power, and materials necessary for tunneling, spoil removal and disposal, tunnel support installation, contact grouting behind tunnel supports, and other associated work required for the Contractor's methods of construction.

E. Conduct all operations such that trucks and other vehicles do not interfere with traffic or create a mud, dust, or noise nuisance in the streets and to adjacent properties. Promptly clean up, remove, and dispose of mud or spoil spillage.

F. All Work shall be done so as not to disturb roadways, railroads, creek channels, adjacent structures, landscaped areas, or existing utilities. Any damage shall be immediately repaired to original or better condition and to the satisfaction of SAWS' Representative, at no additional cost to SAWS.

G. Whenever there is a condition that is likely to endanger the stability of the tunnel or adjacent facilities or structures, the Contractor shall operate with a full crew 24 hours a day, including weekends and holidays, without interruption, until those conditions no longer jeopardize the stability of the Work.

3.02 TUNNEL LINER PLATE

A. Install the tunnel liner plates to the limits indicated and as specified in AASHTO HB-17, Division II, Section 25.

B. When the liner plates are being installed, care shall be taken to maintain alignment, grade, and the circular shape of the tunnel. Plates in consecutive rings shall be installed so that the longitudinal joints in adjacent rings are staggered and not alignment more often than every second ring.

C. The clear inside diameter of the tunnel liner shall meet the requirements noted on the Drawings or as stated elsewhere in these Specifications.

D. Tunnel liner plate shall not be allowed to deflect vertically during installation. If deflections are detected that indicate, in the opinion of SAWS' Representative, a potential safety or stability hazard, take appropriate measures to correct the problem and prevent further deformation.

E. Liner plate installation shall proceed as closely as possible behind the excavation. Excavation shall at no time proceed ahead of the required space to install an individual tunnel liner plate.

F. If inflow of soil through the tunnel liner is detected, take immediate action to correct the problem and prevent further inflow.

G. Maintain an adequate supply of tunnel liner plates at the work site at all times.

3.03 TUNNELING

A. During tunnel excavation, support the ground continuously in a manner to prevent loss of ground and keep the perimeter and face of the tunnel stable. Advance the tunneling shield only far enough to permit construction of one ring of liner plate, entirely within the tail of the shield.

B. Accurately maintain the face of the excavation so as to allow the absolute minimum of void space outside the liner plate. Maintain a maximum of 1/2" tolerance between the outside of the tunneling shield and the excavation wherever possible. In no case shall the excavated tunnel diameter be greater than 4" larger than the tunnel liner O.D., or greater than that recommended by the liner plate manufacturer.

C. Keep the excavation face breasted or otherwise supported and prevent ground losses, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.

D. During shutdown periods, support the face of the excavation by positive means; no support shall rely solely on hydraulic pressure. Face of excavation shall not remain unsupported for more than 12-hours or the end of the last shift for the day. Acceptable support includes flash coat of shotcrete or breasting plates.

E. The tunnel excavation shall be controlled to restrict the excavation of the materials to a volume equal to the liner plate installed, plus the allowable annular space, to prevent loss of ground and settlement or possible damage to overlying structures.

F. The Contractor shall monitor excavated spoil volume. If excavated spoil volume exceeds the theoretical volume of the tunnel liner being installed (including reasonable allowance for soil bulking), the Contractor shall notify SAWS' Representative and promptly modify excavation and face support procedures to prevent further over-excavation.

G. Completely contain, transport, and dispose of all excavated materials away from the construction site. Use only the disposal sites identified in approved submittals for spoil disposal.

H. Tunneling operations shall control surface settlement and heave above the pipeline to prevent damage to existing utilities, facilities, and improvements. In no case shall ground instrumentation and movements (settlement/heave) exceed the values specified in Section 02445 - Settlement Monitoring, and shall not cause damage to adjacent structures, roadways, or utilities. The Contractor shall repair any damage resulting from construction activities, at no additional cost to SAWS and without extension of schedule for completion.

I. The completed tunnel lining shall have full bearing against the ground. The annular space between the liner plates and the excavated ground shall be filled with grout as specified herein. The Contractor shall pressure grout any additional voids caused by or encountered during the shaft construction or tunneling as specified in Section 03360, Contact Grouting.

3.03 INSTALLATION OF CONTACT GROUT

A. Install contact grout in the void space between the outside of the tunnel liner plate and the surrounding excavated ground. At a minimum, install contact grout at the end of each work shift, or more often as conditions warrant. The daily grouting requirement may be waived, at the sole discretion of SAWS' Representative, in instances of very low daily forward progress.

B. After grouting, deflection of the liner shall be no more than allowed in this Specification, nor shall the liner be distorted by excessive pressure.

C. Unless specified otherwise, install contact grout through grout fittings. Remove and plug grout fittings after contact grouting.

D. An attempt shall be made to hook-up and pump grout at every installed grout port.

E. In general, contact grouting at a port shall be considered completed when less than one cubic foot of grout of the accepted mix and consistency can be pumped in 5 minutes under the maximum safe contact grout pressure, or if grout issues forth of the same consistency, and at the same rate as that being pumped, from the next grout port in the line.

F. As grout pumping through any port is stopped, the port shall be plugged to prevent backflow or flow of grout.

G. For liner plates installed in hand-mining excavations, grout once every 4 feet, or more frequently, when conditions dictate.

H. Provide seals on tail of shield or TBM which will prevent grout from spilling.

I. Upon completion of each grouting operation, sound primary liner and immediately correct voids discovered by necessary means approved by SAWS' Representative. After all voids are successfully filled, grout holes will be packed, when necessary, with dry mortar mix and threaded taps securely placed in holes.

J. Contractor shall reference Section SS 03360 – Contact Grouting, where more specific requirements regarding contact grouting are found.

3.04 INSTALLING CARRIER PIPE IN TUNNEL LINER

A. Place, align, and anchor guide rails and/or carrier pipe supports inside the tunnel liner. If guide rails are used, place cement mortar on both sides of the rails.

B. After carrier pipe installation is complete, the annular space between the carrier pipe and tunnel liner shall be completely filled with annular space grout per Section 02426 – Carrier Pipe in Tunnels.

C. Contractor shall reference to Section SS 02426 – Carrier Pipe in Tunnels, where more specific requirements regarding carrier pipe in tunnels are found.

3.05 CONTROL OF LINE AND GRADE

A. The benchmarks and control points indicated on the Contract Document have been established in the field. The Contractor shall verify these benchmarks by survey prior to the start of construction and shall confirm positions or report any errors or discrepancies in writing to SAWS' Representative.

B. After confirming that all established benchmarks provided for the Contractor's use are accurate, use these benchmarks to furnish and maintain all reference lines and grades for tunneling. The Contractor shall use these lines and grades to establish the exact location of the tunnel using a laser or theodolite guidance system. Submit to SAWS' Representative copies of field notes used to establish all lines and grades and allow SAWS' Representative to check guidance system setup prior to beginning each tunneling drive. Provide access for SAWS' Representative to perform survey checks of the guidance system and the line and grade of the carrier pipe on a daily basis during tunneling operations. The system shall be configured to allow SAWS' Representative or designed representative to confirm line and grade by direct observation in tunnel. The Contractor is fully responsible for the accuracy of the Work and the correction of it, as required.

C. The tunnel liner plate shall be installed in accordance with the following tolerances, or within such tolerances that allow for the carrier pipe to be installed on the design line and grade while providing adequate space for annular space grouting, as Specified in Section 02426 – Carrier Pipe in Tunnels:

1. Variations from design line: +/- Six (6) inches maximum.

2. Variations from design grade: +/- Six (6) inches maximum.

D. If the installation is off-line or grade, make the necessary corrections, and return to the design alignment and grade at a rate of not more than one (1) inch per twenty-five (25) feet.

E. Monitor line and grade continuously during tunneling operations. Record deviation with respect to design line and grade once per ten (10) feet of tunnel advancement and submit records to SAWS' Representative daily.

F. If the pipe installation does not meet the specified tolerance, the Contractor shall correct the installation including any necessary redesign of the pipeline or structures and acquisition of necessary easements. All corrective work shall be performed by the Contractor at no additional cost to SAWS and without schedule extension and is subject to the written approval of SAWS' Representative.

3.06 CLEANUP AND RESTORATION

A. After completion of tunneling, all construction debris, spoils, oil, grease, and other materials will be removed from the tunnel, shafts, and all Contractor work areas. Cleaning shall be incidental to the construction. No separate payment shall be made for cleanup.

B. Restoration shall follow construction as the Work progresses and shall be completed as soon as possible. Restore and repair any damage resulting from surface settlement caused by shaft excavation or tunneling. Any property damaged or destroyed, shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than thirty (30) days after the tunneling is complete. This provision for restoration shall include all property affected by the construction operations.

3.07 SAFETY

A. The Contractor is responsible for safety on the job site. Methods of construction shall be such as to ensure the safety of the Work, Contractor's and other employees on site, and the public. Perform all Work in accordance with all current applicable regulations and safety requirements of Federal, State, and local agencies. Comply with all applicable provisions of 29 CFR Part 1926, Subpart S – Underground Construction and Subpart P – Excavations, by OSHA. In the event of conflict, comply with the more stringent requirements.

B. When personnel are underground, furnish and operate a temporary ventilation system, and air monitoring system conforming to the requirements of OSHA. Operate and maintain a ventilation system that provides a sufficient supply of fresh air and maintains an atmosphere free of toxic or flammable gasses in all underground work areas.

C. All Work shall conform to the requirements of OSHA. Gas testing shall be performed by a certified gas tester in accordance with OSHA requirements.

D. All underground construction shall be performed in accordance with the applicable fire prevention and control requirements of OSHA, and any State or local fire agency requirements and/or ordinances.

E. No gasoline-powered equipment or tobacco smoking shall be permitted in jacking/receiving shafts or the tunnels.

3.08 MEASUREMENT AND PAYMENT

A. Unit Prices

1. Tunneling with liner plate shall be measured by linear foot of bore or tunnel along center line as measured from face to face of bore pits.

2. Liners, where required by plans, of the size and material required shall be measured by the linear foot actually installed in accordance with the Contract Documents.

3. Payment will include and be full compensation for labor, equipment, materials and supervision for construction of liner plate and excavation, complete in place, including disposal at excess materials, sheeting, shoring, or bracing, dewatering, utility adjustments, connections to existing sewer, grouting where required, tests, backfilling, cleanup and other related work necessary for construction as specified or as shown on the Contract Documents.

END OF SECTION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This section is intended to supplement SAWS Item 856 – Jacking, Boring or Tunneling Pipe. No modifications to Item 856 are proposed.

B. This Section describes requirements for portal stabilization measures to be taken at shaft locations to prevent soil/rock inflows, and to control groundwater inflows during launching and retrieving of the tunneling equipment. The Contractor shall provide portal stabilization at all shaft penetrations such that no soil/rock and no more than 5 gpm of water enters the shaft when portals are opened for launching or retrieving of the tunneling equipment.

C. The Contractor may provide portal stabilization using grouting methods, guillotine wall (double- wall) methods, methods integral to the shaft construction, or other methods proposed by the Contractor, subject to Consultant's written approval.

D. The Work includes all operations necessary to provide portal stabilization that meets the requirements herein. This includes any secondary measures (such as additional contact grouting) or work required if initial stabilization methods are not successful.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02400 – Tunnel Shafts

B. SS 02314 – Tunneling with Liner Plate

C. SS 02441 – Pipe-Jacked Tunnels

D. SS 02445 – Settlement Monitoring

E. SAWS 804 – Excavation, Trenching and Backfill

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code or standard occur, the more restrictive specification shall govern. The publications are referenced in the text by basic designation only. Where a date is given for referenced standards, that edition shall be used. Where no date is given for referenced standards, the latest edition available on the date of issue of Contract Documents shall be used.

B. San Antonio Water System (SAWS)

1. Specifications for Water and Sanitary Sewer Construction – latest version.

2. Materials Specifications.

C. ASCE Standard Design and Construction Guidelines for Microtunneling, ASCE/CI 36-14.

1.04 DEFINITIONS

A. Portal Stabilization: Where the new trenchless pipelines enter or exit a shaft excavation, the Contractor shall stabilize the portal to prevent soil/rock or groundwater inflows into the shaft that may lead to settlement around the shaft or flooding of the excavation. Portal stabilization may be accomplished using applicable ground improvement, double sheeting methods combined with contact grouting (guillotine method) or may be integral to the shaft construction method (as for auger-drilled shafts and secant pile shafts).

B. Guillotine (Double-Wall) Stabilization Method: To provide stable ground and groundwater control at shaft penetrations, a set of steel sheetpiles is installed just outside the primary shoring system in front of the portal locations. Contact grout is then injected between the primary shoring system and guillotine sheets to confirm that the soil between is stable and will prevent groundwater flow. A hole is then cut in the primary shoring, exposing the stabilized ground and allowing for the insertion of the tunneling equipment into the shaft seal and through the primary shoring. Once the tunneling shield and shaft seal are mated, the guillotine sheets can be lifted out of the tunnel path and removed.

C. Ground Improvement: A prism of stabilized soil is created just outside the shoring system using grouting methods appropriate for the ground conditions. The improved block stabilizes the soil and lowers the permeability of the soil sufficiently to control groundwater inflows. It is important that the stabilized prism is cast tightly against the existing shoring, extending well beyond the portal to be cut in the shoring, so that groundwater cannot flow along the shoring and enter the portal. Any grout/soil-cement strength must also be carefully controlled to allow the tunneling equipment to efficiently excavate it.

1.05 DESIGN CRITERIA

A. The Contractor shall provide portal stabilization to prevent soil/rock inflows and to control groundwater inflows during launch and retrieval of the tunneling equipment for all shaft locations.

B. Portal stabilization methods shall ensure that no soil/rock and no more than 5 gpm of water enters the shaft when creating portals for the launch or retrieval of the tunneling equipment, as required in Paragraph 3.03 A.

C. The Contractor may accomplish portal stabilization by the use of ground improvement, the guillotine wall (double-wall) method, methods integral to the shoring system (such as for auger- drilled shafts and secant piles) or by other Contractor suggested methods, subject to the requirements of these Specifications and SAWS or Engineer written approval. Multiple options for achieving portal stabilization, including an allowance for contractor-suggested methods, are presented to allow flexibility for contractor preference. Not all methods listed are appropriate for all ground conditions. It is the sole responsibility of the Contractor to choose portal stabilization methods that are appropriate for the ground conditions at each shaft.

D. The maximum 28-day compressive strength of any grout used, or soil-cement created shall not exceed 150 psi. The minimum 24-hour compressive strength shall be at least 10 psi.

Additionally, the cured grout or soil-cement shall be of a strength that can be efficiently excavated by the tunneling equipment without damage to the equipment.

E. Guillotine Wall (Double-Wall) Method:

1. The Contractor shall accomplish this method of stabilization by inserting a secondary set of interlocking steel sheetpiles just outside of the primary shoring system. The guillotine wall shall extend not less than three (3) feet beyond the maximum portal dimensions to be opened in the primary shoring system, in all directions.

2. The contractor shall inject contact grout between the primary shoring system and the guillotine wall, as necessary, to stabilize the soil between and to seal any voids that will allow groundwater flow into the shaft, before opening tunnel portals.

F. Ground Improvement: Where ground improvement is used for portal stabilization, the Contractor shall:

1. Choose ground improvement methods that will achieve the required stability in the ground conditions as described in the Geotechnical Data Reports, for each shaft location.

2. The prism of improved ground shall extend not less than three (3) feet beyond the maximum portal dimensions to be opened in the primary shoring system in all directions.

1.06 QUALITY ASSURANCE – Not Used

1.07 SUBMITTALS

A. Submittals shall be made in accordance with SAWS's requirements. Review and acceptance of the Contractor's submittals by the Consultant shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

B. Portal Stabilization:

1. Provide a description of the methods to be used for each portal stabilization technique proposed. Provide shop drawings showing the details and dimensions of each stabilization system and full narrative describing the procedures.

2. Provide a list of which portal stabilization method will be used at each shaft location.

3. Provide a description of the secondary or remedial methods that will be employed if the initial stabilization efforts fail to achieve the required stabilization as described in Paragraph 3.03 A.

4. Provide mix designs for any concrete or grout proposed as a part of the portal stabilization work.

PART 2 – PRODUCTS – Not Used

PART 3 – EXECUTION

3.01 GUILLOTINE WALL METHODS

A. The Contractor shall visually verify the location of all utilities that may cross or are within 5 feet adjacent to the location of guillotine sheets before commencing sheetpile installation.

B. Pre-drilling of the soils may be necessary to install sheetpiles to the required depths.

C. Guillotine sheets shall be completely removed after the tunneling equipment has been seated in the shaft seal.

3.02 GROUND IMPROVEMENT METHODS

A. Prisms of improved ground shall be installed in full contact with the shoring to prevent uncontrolled groundwater flow along the shoring face and into the portals. If ground improvement cannot be performed tight against the shoring face, supplemental contact grouting shall be used to achieve control of groundwater inflows.

3.03 VERIFICATION OF STABILITY

A. The Contractor shall stabilize the soils at all tunnel portal locations to prevent the inflow of weak, running, or flowing soils or loose rock and to control groundwater inflows. The Contractor shall confirm that the ground has been stabilized to the extent that ground will remain stable without movement of soil/rock or water while the entry/exit location shoring is removed and while the tunneling equipment is being launched or received into a shaft or during jacking operations. The progressive steps identified below shall be used to confirm suitable stabilization has been achieved for all shaft types and entry/exit locations:

1. After the Contractor believes he has stabilized the ground sufficiently outside a given shaft seal, the Contractor shall demonstrate the stability of the ground by cutting a 3-inch diameter hole in the shoring wall near the center of the bore. If no soil/rock and less than 5 gpm of water enters the shaft, the Contractor may progress to the next demonstration step. If soil/rock or more than 5 gpm of water enter into the shaft, the Contractor shall seal the demonstration hole and further stabilize the ground before repeating the demonstration step.

2. After successful completion of the first demonstration step, the Contractor shall demonstrate the stability of the ground by cutting a 12-inch diameter hole in the shoring wall at the location of previous demonstration hole. If no soil/rock and less than 5 gpm of water enters the shaft, the Contractor may progress to the next

demonstration step. If soil/rock or more than 5 gpm of water enters the shaft, the Contractor shall again seal the demonstration hole and further stabilize the ground before repeating the demonstration step.

3. After successful completion of the first two demonstration steps, and if the Contractor believes the portal stabilization work is sufficient, the Contractor may proceed with remainder of the shaft wall penetration procedures.

4. Successful completion of shaft wall penetrations and related activities necessary to demonstrate such shall be at the Contractor's sole expense.

PART 4 – PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. This item is considered subsidiary to the work and no separate payment will be made to the Contractor for the work.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction, maintenance, and backfilling requirements of tunnel shafts. This Section specifies the minimum requirements and acceptable construction methods for excavation and support of shafts for trenchless crossings. The shafts will also be used to facilitate the construction of connections, manholes, and other permanent structures shown on the Drawings.

B. The Contractor shall design, furnish, install, and maintain a system of temporary supports, including all bracing and associated items, to retain excavations in a safe manner, to control ground movements, and to control groundwater inflows. Upon completion of the required excavation and pipe installation, the Contractor shall remove the support system, as specified, and backfill the excavations.

C. The Contractor shall have sole responsibility for selection of shaft type, construction method, exact location, and sizing of the excavations, subject to the requirements of this Section, to accommodate shoring, bracing, and pipe installation to the specified lines, grades and tolerances. The shafts shall be sized to facilitate construction of manholes, connections, vaults, and other permanent structures shown on the Drawings.

D. The Work shall include site grading; temporary access road construction; fencing and signage; protection of utilities; construction staging areas; design and construction of shaft excavations and excavation support systems; material disposal; control and disposal of groundwater, surface water, and construction water; backfilling and abandoning shafts; and site restoration.

E. In general, acceptable shaft types include: soldier piles and lagging, and liner plate shafts. Due to site restrictions at certain shaft locations, allowable shaft construction methods may be limited. See Drawings for allowable shaft types for each specific location. Due to anticipated unstable ground in saturated conditions, external dewatering is required at certain shaft locations.

1.02 DEFINITIONS

A. Liner Plate Shaft: A shaft formed by sequential excavation and erection of support rings consisting of segmental steel liner plates. All voids between the excavation and the liner plates are backfilled with grout to ensure complete contact with the ground. A liner-plate shaft is generally considered a non-watertight shaft. External dewatering may be required if groundwater levels are above shaft invert.

B. Soldier Pile and Lagging Shaft: A non-watertight excavation support system composed of vertical steel piles, wales, struts, and lagging. The vertical piles extend from ground surface to a sufficient depth below the final excavation depth to provide adequate resistance against earth pressures. Lagging, consisting of wooden boards or steel sheets is inserted between the flanges of the adjacent H-beams to support the excavation and prevent soil from sloughing or caving into the excavation. Wales are horizontal support beams installed and

welded to the vertical soldier piles to stiffen the support system and are sized and installed at a vertical spacing to safely support external earth loads. The shaft bottom is covered with a concrete slab with one or more sumps. External dewatering may be required if groundwater levels are above shaft invert.

1.03 SUBMITTALS

A. Shaft design submittals by Contractor shall be signed and sealed by a Professional Engineer registered in the State of Texas.

B. 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. Also provide the following information for each shaft:

1. Site plan for each shaft indicating location of shaft by station, excavation dimension, site grading, site development details for excavation and proposed work areas and limits of disturbance surrounding each excavation.

2. Provisions for protecting and monitoring adjacent facilities and utilities. Address utilities and structures within 25 feet of excavation.

3. Description of site security arrangements in conformance with Paragraph 3.03, Shaft Construction.

4. Methods for grouting voids around shaft excavation to minimize ground movement and protect adjacent structures or utilities.

5. Methods and sequencing of excavation and installing of shaft wall support reinforcement of tunnel penetration in shaft wall and seal slab.

6. Description of method of extending shaft above flood level in conformance with Paragraph 3.03, Shaft Construction.

7. Any geotechnical/boring undertaken by Contractor for whatever purpose connected to Work.

C. 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.

D. 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. Account for impact from such structures in design submittal and shaft construction drawings. Include photographs or video of any existing damage to structures in vicinity of shafts in assessment reports.

E. 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.

F. Submit readings of monitoring plans to SAWS and Engineer as soon as readings have been taken.

G. Submit shaft temporary deck drawings and calculations to SAWS and Engineer, 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, Shaft Construction.

1.04 PERFORMANCE REQUIREMENTS

A. 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.

B. Design shaft to support earth pressure, unrelieved hydrostatic pressures, bottom heave, utility loads, equipment, applicable traffic loads, and other surcharge loads in such manner as will allow safe construction and will prevent damage to adjacent structures (including existing pipelines and utilities) and injury to workers and the public. In addition, the installation of excavation support systems shall not cause a disruption to public convenience or access.

C. Design shaft located within 100-year flood plain with water retaining liner extending 2 feet above 100-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.

D. Excavation support systems shall be designed to be compatible with the geologic conditions as described in the Geotechnical Report and the conditions anticipated by the Contractor.

E. The design of shoring and protection methods that meet the Specification requirements herein are the Contractor's responsibility. Shafts shall be of a shape and size large enough to facilitate all the necessary groundwater control, construction operations, pipeline equipment and operations, tunneling operations, construction of appurtenances, such as manholes, etc., and to accommodate indicated connections to other reaches of the project. Shoring design is subject to review and approval by the SAWS.

F. Design steel plate deck, if such is required, for HS-20 loading

G. Shaft design calculations shall include all phases of the shaft construction including installation, operation and removal. The minimum factor of safety for any phase of the work shall be 1.5.

H. Provide a means for securing timber or steel lagging to soldier piles or ribs in cohesionless soils to avoid shifting or falling off of lagging.

PART 2 PRODUCTS

2.01 MATERIALS

A. All structural steel used for the support systems, whether new or used, shall be sound and free from defects which may impair strength.

B. Fabricated connections and accessories shall conform to the requirements of ASTM A36.

C. Structural Steel Bracing: ASTM A36. Steel rolled shapes shall be ASTM A572 steel.

D. Structural Steel Soldier Piling: ASTM A572, Grade 50, HP or W per AISC Steel Manual.

E. Timber Lagging Wood: Wood lagging shall be dimension lumber with minimum tabulated unit stress in bending of 1,000 psi. The stress grade shall be in conformance to allowable stressed of UBC, Chapter 25.

F. Liner Plate: AASHTO HB-17 "Standard Specifications for Highway Bridges", Section 15

1. Steel liner plates may be either 2-flange or 4-flange type, 16 inches to 24 inches in width.

2. Tunnel Liner Plates and fasteners shall comply with the requirements of AASHTO HB-17.

3. Liner plates shall be punched for bolting on both longitudinal and circumferential seams and fabricated to permit complete erection from the inside of the tunnel shaft.

4. Where shown on the Drawings, gasketed liner plates shall be used.

5. Every other plate radially of every second ring vertically shall be fitted with a minimum 1-1/2-inch diameter grout hole.

6. Field welding of Tunnel Liner Plate, including grout couplings shall not be allowed.

7. The material used for the construction of these plates shall be new, unused and suitable for the purpose intended.

8. Bolts used with lapped-seam (2-flange) liner plates shall be not less than 5/8" diameter. Bolts shall conform to ASTM A-449 for plate thickness equal to or greater than 0.209", and to ASTM A-307 for plate thickness less than 0.209". The nuts shall conform to ASTM A-307.

9. Bolts used with 4-flange liner plates shall be not less than ½" diameter for plate thickness up to and including 0.179", and not less than 5/8" diameter for plates of greater thickness. The bolts and nuts shall be quick-acting coarse thread and shall conform to ASTM A-307, Grade A.

PART 3 EXECUTION

3.01 LOCATION OF ACCESS SHAFTS

A. Contractor has sole responsibility for selection of shaft sites needed for construction operations unless otherwise indicated on Drawings. Location will be subject to approval of the Project Manager.

B. 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.

C. 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.

3.02 UTILITY RELOCATION

A. Relocate utilities as shown on Drawings. Utility relocations required by Contractor for shaft construction shall take into account zone of potential settlement in vicinity of shaft.

B. Obtain approval from Project Manager for permanent relocations prior to relocating.

3.03 SHAFT CONSTRUCTION

A. Conform to the following for ground support systems:

1. Install liner elements, bracing and shoring structural members at locations and in method sequence and tolerances defined on shaft construction drawings as excavation progresses.

2. 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 SAWS.

3. 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.

4. 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.

5. 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.

6. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.

7. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels. 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.

B. Install suitable thrust or reaction blocks as required for pipe jacking equipment.

C. 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.

D. Surface Water Control. Divert surface water runoff and discharge from dewatering system away from shaft. Protect shafts from infiltration or flooding.

E. Each surface work site is to be surrounded by security fence, which shall be secure any time site is unattended by Contractor's personnel.

F. Protect shaft, when not in use by second security fence at perimeter of shaft, or alternatively by cover designed in accordance with Paragraph 1.04, Performance Requirements.

G. 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.

H. 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.

I. 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.

J. Size of Shafts: Make size adequate for construction of permanent structures indicated on Drawings and to provide adequate room to meet operational requirements for tunnel construction and backfill.

3.04 BACKFILL

A. 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. Compact cement-stabilized sand. In locations where backfill is not subject to traffic loading, depth above initial cement-stabilized sand may be backfilled with select backfill. When insufficient work space exists, Grout manhole or structure annular space.

B. Remove shaft liner above level of 8 feet below ground surface, unless otherwise indicated on Drawings. Maintain sufficient ground support to meet excavation safety requirements while removing shaft structure.

3.05 MONITORING

A. Monitoring Instrumentation. Instrumentation specified and readings shall be accessible at all times to Project Manager.

1. 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.

2. 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.

3. Install instruments in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring

1. Establish monitoring points on all critical structures and along surface of the centerline of utilities near shaft construction.

2. 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.

3. 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.

4. Railroads. Monitor ground settlement of track subbase at centerline of each track when within zone of potential settlement.

C. Reading Frequency and Reporting. Submit weekly to Project Representative, records of readings from various instruments and survey points.

1. 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.

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

3. Following substantial completion but prior to final completion, make final survey of all shaft related monitoring points.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Handling, transporting, and installing sanitary sewer lines in primary lined tunnels.

1.02 DEFINITIONS

A. Primary Liner: Contractor's initial construction liner and tunnel support installed by contractor for ground stability and safety during construction preparatory to installation of water line.

B. Carrier Pipe: Permanent pipe for operational use that will convey flows.

C. Steel Casing Pipe: A pipe installed by direct-jacking using pipejacking methods. The steel casing pipe supports the ground and provides a stable underground excavation for installation of the carrier pipe.

D. Liner Plate Tunnel: A tunnel shaft support system installed by conventional tunneling means (hand mining or mechanical excavation) which supports the ground and provides a stable underground excavation for installation of the carrier pipe.

1.03 SUBMITTALS

A. Provide brief description of method of transporting carrier pipe into tunnel; method of hoisting and positioning pipe; method of jointing and aligning pipe; blocking plan; and tunnel ventilation while setting pipe and completing joints, when applicable.

B. Submit buoyant force calculations, bulkhead design, and blocking details. Include in calculations analysis of stresses and deformation induced on carrier pipe. Submittal must be signed and sealed by Professional Engineer registered in State of Texas.

PART 2 PRODUCTS

2.01 PIPE MATERIAL AND FITTINGS

A. Sewer pipe may consist of fiberglass pipe (FRP), and polyvinyl chloride (PVC) pipe, as shown on the Drawings.

2.02 CASING SPACERS

A. Casing spacers shall be designed by the manufacturer to adequately support the carrier pipe within the casing pipe under all conditions. Number and location of casing spacers shall be determined by the manufacturer to protect carrier pipe from damages and maintain proposed grade.

B. Casing spacers shall conform to SAWS' Material Standard Specification 05-31-Specification for Casing Insulators.

C. Acceptable manufacturers and models shall be those listed in SAWS' Material Standard Specification 05-31-Specification for Casing Insulators.

2.03 CASING END SEALS

A. Casing end seals shall be sized by the Contractor to accommodate the diameter of the casing pipe. These seals shall be installed using brick mortar end seals as shown in the Contract Documents. Contractor shall support the end seals during grout-filling operations.

2.04 BLOCKING

A. Untreated, construction-grade hardwood that is sound, free from decay, torn grain, and other defects.

B. Steel shapes with appropriate measures to protect pipe and coating from damage.

PART 3 EXECUTION

3.01 INSTALLATION TOLERANCES

A. Prior to installing sewer pipe, verify that primary liner has been constructed so that sewer pipe may be placed in conformance with specified tolerances.

B. Tolerances from lines and grades shown on Drawings for sewer pipe installed in primary liner are plus or minus 6 inches in horizontal alignment and plus or minus 1-1/2 inches in elevation. Should misalignment of primary liner preclude installation of sewer pipe to tolerances specified, notify Project Manager

3.02 PIPE HANDLING

A. Handle and transport pipe into tunnel in manner that prevents damage to pipe, joints, gaskets, and plastic liner. Do not install pipe damaged during placement operations. If damaged, propose pipe repair procedures for review and approval of Project Manager.

3.03 TUNNEL CLEANUP

A. Prior to pipe placement in tunnel, remove temporary tunnel utilities, such as electrical and ventilation. Remove loose material, dirt, standing water, and debris prior to pipe placement.

B. Temporary steel construction tracks or steel pipe skids may be left in place when they do not interfere with alignment of sewer pipe or interfere with final placement of annular grout.

3.04 INVERT PIPE SUPPORT

A. Provide support adequate to establish final pipe grade. Support may include screeded concrete, steel beam, or other method as designated by Contractor's Engineer. Secure pipe support to pipe or primary liner. When concrete is used for pipe support, cure it minimum of 12 hours prior to setting pipe.

3.05 JOINING PIPE IN TUNNELS

A. Join pipe segments to properly compress gaskets and allow for correct final positioning of pipe for line and grade. Closely align pipes by bringing them loosely together by means of hydraulic jacks, locomotives, pipemobiles, or winches. Once pipes have been loosely joined, pull them home by means of hydraulic tugger or other similar method suitably protecting pipe and joints against damage. Impact jointing such as ramming with locomotives or other mechanical equipment is not permitted.

3.06 BLOCKING PIPE IN TUNNEL AND BULKHEADS

A. Install pipe blocking system. Use pipe blocking to position sewer pipe in tunnel to allow minimum of 4 inches of grout to be placed between sewer pipe and tunnel primary liner or casing.

B. Secure blocking rigidly in place without dependence on wedges to prevent dislodging during pipe placement and grouting operations.

C. Construct bulkheads to withstand imposed grout pressure without leakage. Provide adequate venting for bulkheads.

3.07 ACCEPTANCE TESTING

A. Perform as-built survey on installed sewer pipe. Take invert elevations at each pipe joint. Take two diameter readings, at right angles, randomly at average of 20 feet spacing or 10 feet non-rigid pipe.

B. Test for leakage by low pressure air methods.

3.8 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Length of sewer installed in primary lined tunnels will be measured by linear foot along center line of completed sewer, 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 stations 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 for installation of sewer in primary lined tunnels is on a linear foot basis.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the minimum requirements for the installation of casing pipe using open-shield pipejacking such as jacking pipe following hand-shield excavation, or closed-shield pipejacking methods such as tunnel boring machine (TBM) or micro-tunnel boring machine (MTBM).

B. A tunnel shield is required at all locations where liner plate is allowed, unless specifically noted otherwise on Contract Documents. In certain locations only non-rotary shields are allowed due to the anticipated mix-face conditions. See the Drawings for location where only non-rotary shield are allowed.

C. Certain locations require lowering of existing groundwater to below tunnel invert elevation prior to tunneling work. Perform all dewatering work in accordance to Sections SS 2242 – Water Control for Shaft Tunnel Construction and SS2140 – Control of Ground and Surface Water.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02245 – Settlement Monitoring.

B. SS 02610 – Steel Casing Pipe.

C. SS 02140 – Control of Ground and Surface Water.

D. SS 02242 – Water Control Shaft Tunnel Construction.

E. SS 01050 – Survey Controls.

1.03 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO).

B. Occupational Safety and Health Administration (OSHA).

C. National Electrical Code - (NFPA 70).

1.04 DEFINITION

A. Pipejacking. Pipejacking is a technique for installing a casing pipe from a jacking shaft to a receiving shaft, using jacks. Soil/rock excavation is carried out within a shield in front of the lead pipe segment using hand-mining, mechanical methods such as a roadheader or digger-boom, or with mechanized equipment such as a rotary tunnel boring machine (TBM) and microtunneling boring machine (MTBM). The excavation method should be chosen to be compatible with the anticipated ground conditions. The shield is steerable using hydraulic or mechanical jacks to orient an articulated section of the shield, and

guidance is provided using a laser, theodolite, or gyroscope system supplemented with a water level if necessary.

B. Jacking Pipe. Method for installing a casing 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.

C. Microtunneling. Method of installing pipe by jacking the casing pipe behind microtunnel boring machine which is connected to and shoved forward by pipe being installed, generally precluding man entry.

D. Tunnel Boring Machine (TBM). Mechanized excavating equipment that is steerable, guided and articulated, connected to and shoved forward by the casing being installed, with man entry.

E. 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.

F. Tunneling Methodology. Written description, together with supporting documentation that defines plans and procedures for pipe jacking operations.

G. Zone of Active Excavation. Area located within radial distance about surface point immediately above face of excavation equal to depth to bottom of excavation.

H. Critical Structure. Building, structure, bridge, pier, or similar construction partially or entirely located within zone of active excavation.

I. Open Shield. Face of heading or tunnel which is unsupported during excavation (e.g., in hand-mining or shield excavation).

J. Close Shield. 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.

K. Primary Tunneling Line: Elements designed, fabricated, furnished, installed, monitored, and maintained in the tunnel by the Contractor for initial ground support to provide excavation stability and safety during construction. The primary liner provides temporary ground support to allow for the installation of the final gravity sewer pipe and annular space grout which serve as the final lining system.

1.05 SUBMITTALS

A. 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.

i. Procedures for measuring excavation quantities versus forward progress during tunneling operation (for TBM only).

j. Method of controlling line and grade of excavation.

k. Submit tunnel jacking force calculations – need to provide jacking system with 2.0 times jacking forces calculated or provide intermediate jacking stations.

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, show casing 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 post construction assessment reports for critical structures, namely those located within zone of active excavation from proposed tunnel centerline. Include photographs or video of existing damage to structures in vicinity of sewer alignment in assessment reports.

7. Readings of all monitoring shall be submitted weekly to SAWS. Any readings outside of the allowable shall be reported immediately.

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 casing and 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 casing 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 for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.

E. Provide casing 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 CASING PIPE

A. Assume responsibility for selecting appropriate casing and joints to safely carry loads imposed during construction, including jacking forces. Casing joints shall be flush with outside face when re assembled.

B. Use casing that is round with smooth, even outer surface, and has joints that allow for easy connections between pipes. Design pipe so that jacking loads are evenly distributed around entire pipe joint and such that point loads will not occur when pipe is installed.

C. 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.

D. Casing Pipe. Provide new uncoated welded steel pipe, manufactured in accordance with AWWA C200.

E. Design stress in pipe wall shall be 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.

F. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.

G. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.

H. Minimum thickness of steel shall be as shown on drawing.

I. Casing pipe design shall also include stresses due to jacking forces when pipe is to be installed by jacking method.

J. 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.

PART 3 EXECUTION

3.01 CONSTRUCTION OPERATIONS CRITERIA

A. Use methods for 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

A. Provide ground water control measures in conformance with Section 02140 - Control of Ground and Surface Water and Section 02242 Water Control for Shaft Tunnel Construction, when necessary to perform Work.

3.03 EQUIPMENT

A. Tunneling method or equipment which Contract can demonstrate based on past experience will produce specified results for soils encountered will be considered. However, use tunneling methods, whether hand or machine, with full-face closure capabilities or provisions for immediate breastboarding of face unless otherwise shown on Drawings or specified elsewhere.

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 Hand-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. Limit slurry pressure to avoid frac-out to ground surface.

    c. Includes separation process. Design it to provide adequate separation of spoil from slurry so that slurry with sediment content within limits required for successful tunneling can be returned to cutting face for reuse. Appropriately contain spoil at site prior to disposal.

    d. Uses type of separation process suited to size of tunnel being constructed, soil type being excavated, and work space available at each work area for operating plant.

    e. Allows composition of slurry to be monitored to maintain slurry weight and viscosity limits required.

2. In case of cased auger earth pressure balance system, system shall be capable of adjustments required to maintain face stability for particular soil condition to be encountered. Monitor and continuously balance soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.

    a. In cased auger spoil transportation system, manage pressure at excavation face by controlling volume of spoil removal with respect to advance rate. Monitor speed of rotation of auger flight, and addition of water.

3. Remote Control System. Provide MTBM which includes remote control system with following features:

    a. Allows for operation of system without need for personnel to enter tunnel. Has display available to operator, at remote operation console, showing position of shield in relation to design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force, and cutter head torque; rate of advance and installed length.

    b. Integrates system of excavation and removal of spoil and its simultaneous replacement by pipe. As each casing 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 casing 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 casing following tunneling excavation equipment towards receiving shaft.

3. Has sufficient jacking capacity to push tunneling excavation equipment and string of casing 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 casing by use of spreader rings and packing, measured by operating gauges.

6. Provides and maintains casing 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 casing 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

A. 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 jacking pressures per drive.

5. Location, elevation and brief soil descriptions of soil strata.

6. Ground water control operations and piezometric levels.

7. Observation of any lost ground or other ground movement.

8. Any unusual conditions or events.

9. Reasons for operational shutdown in event drive are halted.

3.05 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 casing 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. Casing Jacking

1. Cushion joints as necessary to transmit jacking forces without damage to casing or joints.

2. Maintain envelope of bentonite slurry around exterior of casing during jacking and excavation operation to reduce exterior friction and possibility of casing seizing in place.

3. If casing 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 a section of casing 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 casing.

5. AT all time maintain standby face supports to allow for immediate use when needed.

6. At end of each shift and whenever excavation is suspended, install breast boards, or other approved methods, across full face of excavation.

7. The casing pipe, insofar as practical, jack from low or downstream end. Lateral or vertical variation in final position of casing pipe from line and grade as established by Engineer will be permitted only to extent of 1 inch in 10 feet, provided that variation is regular and only in one direction and that final grade of flow line is in direction indicated on plans. Remedy overcutting by pressure grouting entire length of installation. Use of grout mix immediately behind shield tail shall have efficient tail seal to prevent flow of grout into shield.

8. 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.

C. Interlocking Casing Pipe

1. Install in accordance with manufacturer's recommendations.

2. Remove protective film from connecting surfaces prior to mating using a petroleum based solvent.

3. Prepare ends by cleaning with a firm bristle or wire brush and petroleum-based solvent. Wipe clean and dry with shop towel or rag. Machine surface must be dry, clean, smooth, and free of rust and dirt.

4. Apply RTV Silicone to male and female connectors, making sure that a continuous bead of silicone encircles the circumference. Spreading or troweling silicone is optional. Align pipe straight and mate the connectors

3.05 CONTROL OF LINE AND GRADE

A. Construction Control. Contractor shall reference Specification SS 01050 – Survey 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. 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 1-1/2 inches in elevation from theoretical.

5. Pipe installed outside tolerances and subsequently abandoned shall first be fully grouted.

3.06 MONITORING

A. Instrumentation Monitoring and Surface Settlement Monitoring. Contractor shall reference Specification SS 02445 Settlement Monitoring.

3.07 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. Monitoring will be paid for a lump sum price for installations, observations, and reporting.

END OF SECTION

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), with pipe serving as both tunnel liner during construction and sewer pipe after completion of construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02245 – Settlement Monitoring.

B. SS 02610 – Steel Casing Pipe.

C. SS 02140 – Control of Ground and Surface Water.

D. SS 02242 – Water Control Shaft Tunnel Construction.

E. SS 03360 – Contact Grouting.

F. SS 01050 – Survey Controls.

1.03 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO).

B. Occupational Safety and Health Administration (OSHA).

C. National Electrical Code - (NFPA 70).

1.04 DEFINITION

A. Direct Pipejacking: 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. 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.

C. Open Shield. Face of heading or tunnel which is unsupported during excavation (e.g., in hand-mining or shield excavation).

D. Close Shield. 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.

E. Tunneling Methodology. Written description, together with supporting documentation that defines plans and procedures for pipe jacking operations.

1.05 SUBMITTALS

A. 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. If use of mechanized excavating equipment is proposed, submit drawings and technical specifications of machine and associated equipment including any modifications, experience record with this type of equipment, and Contractor′s experience and training records for the equipment operator.

   c. 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.

   d. Type of lighting and ventilation systems.

   e. Number and duration of shifts planned to be worked each day.

   f. Sequence of operations,

   g. Locations of access shafts and work sites.

   h. Method of controlling line and grade of tunneling operation.

   i. Method of spoil transportation from face, surface storage and disposal location.

   j. Capacity of jacking equipment and type of cushioning.

   k. Grouting technique meeting requirements of SS 03360 – Contact Grouting.

2. Drawings and Calculations: Submit for record purposes, drawings and calculations for any tunnel support system designed by the Contractor.

   a. Provide adequate drawings and installation details for construction. For pipe jacking and show pipe and pipe joint detail, including the pipe stress calculations based on jacking loads. Documents must be signed and sealed by Professional Engineer registered in State of Texas.

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 by the Contractor, submit results to SAWS and Design Consultant for record purposes.

5. Monitoring Plans:

    a. Instrumentation Monitoring Plan: Submit for review, prior to construction, monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

    b. Surface Settlement Monitoring Plan. Submit settlement monitoring plan for review prior to construction. Identify on plan location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

6. Structures Assessment. Provide preconstruction and post construction assessment reports for critical structures, namely those located within zone of active excavation from proposed tunnel centerline. Include photographs or video of existing damage to structures in vicinity of sewer alignment in assessment reports.

7. Readings of all monitoring shall be submitted to SAWS and Design Consultant.

8. Daily Reports: Maintain shift log as defined in Paragraph 3.04, Pipe-jacked Tunneling Data, and make available to SAWS and Design Consultant on request.

1.06 DESIGN CRITERIA

A. Contractor is responsible for selection of the 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 by the Contractor, based on selected method of construction.

B. Jacked pipe shall be designed to withstand thrust from 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. All design assumptions regarding subsurface conditions, equipment requirements, groundwater and other factors are the responsibility of the Contractor and shall be fully documented.

E. Criteria to be used for truck loading shall be HL-20 vehicle loading distributions in accordance with the AASHTO LRFD Bridge Design Specification.

F. Provide pipes of diameter shown on Drawings. Substitution of pipe with larger diameter to suit TBM equipment availability will only be permitted if demonstrated to satisfaction of SAWS and Design Consultant that design flows and velocities can be achieved.

G. Tunneling excavation method shall be capable of excavating through full face bedrock conditions, as may be encountered along the tunnels.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fiberglass Reinforced pipe, joints, and fittings to be in accordance with Section SPT 857 - Glass-Fiber Reinforced Pipe for Large Diameter Gravity Sanitary Sewers.

B. 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.

C. Provide 2-inch diameter grout ports in wall of pipe when required. Provide plugs of 316 stainless steel or other corrosion-resistant material compatible with pipe. Place hole in a pattern so that each succeeding hole from to dead center is 60 degrees right, then 60 degrees left, then top dead center. Locate hole in no more than 5 feet apart. Design and install grout port plugs to meet pipe test pressure.

D. 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.

E. Do not exceed 40 percent of allowable jacking /pushing capacity of ultimate compressive strength or maximum allowable compressive strength recommended by manufacturer, whichever is less.

PART 3 - EXECUTION

3.01 CONSTRUCTION OPERATIONS CRITERIA

A. Use methods for 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 highways, or streets, perform installation so as to avoid interference with operation of highways, or streets, except as approved by owner of facility.

3.02 GROUND WATER CONTROL

A. Provide ground water control measures in conformance with Section 02140 – Control of Ground and Surface Water and Section 02242 – Water Control for Shaft Tunnel Construction, when necessary to perform Work.

3.03 EQUIPMENT

A. Contractor shall be responsible for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.

B. The Contractor shall 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.

C. 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.

D. 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. Shield shall be continuous around it full perimeter; open bottom shield not acceptable.

2. Have hood, poling or breasting plates, shelves and breast jacks, breast tables, and combination of these and other bracing as necessary to fully support face of tunnel excavation without loss of ground.
3. Have tail section long enough to enable setting of initial supports within shield while still providing at least 12-inches of overlap beyond last-installed support elements when shield has been pushed forward to fullest extent possible.

4. Have propulsion system for moving shield in forward direction, while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel support. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.

5. Have motors and operating controls protected against water inflow.

6. Incorporate seal in tail of shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.

E. 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.

F. Air Quality. Provide equipment to maintain proper air quality of manned tunnel operations during construction in accordance with OSHA requirements.

G. Enclose lighting fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting, and other equipment.

H. Electrical systems shall conform to requirements of National Electrical Code - NFPA70.

3.04 PIPE-JACKED TUNNELING DATA

A. Maintain shift logs of construction events and observations. SAWS and Design Consultant shall have access to all logs with regard to following information:

1. Location of boring machine face or shield by station and progress of tunnel drive during shift.

2. Hours worked per shift on tunneling operations.

3. Completed field forms, such as steering control logs, for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment.

4. Maximum pipe jacking pressures per drive.

5. Location, elevation and brief soil descriptions of soil strata.

6. Ground water control operations and piezometric levels.

7. Observation of any lost ground or other ground movement.

8. Any unusual conditions or events.

9. Reasons for operational shutdown in event drive are halted.

3.05 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-shield 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-shield 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. Provide heavy-duty jacks of capacity suitable for forcing pipe through ground. Construction operating jacks so that even pressure is applied to all jacks used. Provide suitable jacking head and suitable bracing between jacks and jacking head. Provide suitable jacking frame and/or back stop.

2. Set pipe on guides to support section of pipe being jacked and to direct it in the proper liner and grade. Conform excavation of underside of pipe to the contour and grade of pipe.

3. Excavate ground material head of pipe by using air-powered tools, excavating machine or other acceptable means. Dispose of excavated material as specified.

4. Open Shield Excavations additional requirements:

a. Excavate face commencing at crown and proceed down to invert. Excavate heading so that both sides of heading are excavated simultaneously.

b. At all times maintain standby face supports to allow for immediate use when needed.

c. At end of each shift and whenever excavation is suspended or shut down, install breast boards, or other approved methods, across full face of heading.

5. Cushion pipe joints as recommended by pipe manufacturer to transmit jacking forces without damage to pipe or pipe joints.

6. Lubricate annular space to minimize jacking loads. 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. Control slurry pressuring to within safe buckling capacity of pipe.

7. If pipe seizes up in place and elect to construct recovery access shaft, obtain approval from SAWS and Design Consultant. Coordinate traffic control measures and utility adjustments as necessary prior to commencing work.

8. Do not exceed forces recommended by manufacturer for coupling pipe. If excessive force is required, remove coupling, determine source of problem, and correct it.

9. Depending on character of soil encountered during jacking operation, carry on operation without interruption, insofar as practical, to prevent pipe from becoming firmly set in ground.

10. When pressure grouting pipe, seal grout holes with liner resin to a thickness equal to pipe liner thickness or with a threaded plug for that purpose.

11. Apply joint lubricant to bell interior surface and elastomeric seals. Use only lubricants approved by pipe manufacturer.

12. 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 SS 03360 – Contact Grouting.

3.06 RISK AND CONTINGENCY PLANS

A. The Contractor should be prepared to drill through mixed soil/bedrock face conditions and/or bedrock conditions.

B. The Contractor shall prepare and implement an approved contingency plan dealing with key project or direct pipe jacking tunneling risks identified. As a minimum, the Contractor shall have defined plans complete with equipment and materials on standby to mitigate against the following direct pipe jacking tunneling risks:

1. Shaft/pit collapse
2. Tunnel collapse

3. Shift/pit flooding
4. Tunnel flooding
5. Mechanical failure
6. Settlement or heave scenarios
7. Serious safety or environmental incidents
8. High water inflows at the face of the TBM which prevents access to machinery
9. Higher jacking forces then expected
10. Large boulder and/or structures encountered. Requiring the abandonment of the bore
11. Pipe damage and joint failure during jacking operations

3.07 CONTROL OF LINE AND GRADE

A. Construction Control. Contractor shall reference Specification SS 01050 – Survey Control.

1. SAWS and Design Consultant will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report any errors or discrepancies to SAWS and Design Consultant.

2. Use baselines and benchmarks established by SAWS and Design Consultant 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. Advise SAWS and Design Consultant 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 TBM or shield after each shove to ensure alignment is within specified tolerances. Make immediate correction to alignment before allowable tolerances are exceeded.

3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.

4. Acceptance criteria for sewer pipe shall be plus or minus 6-inches in horizontal alignment from theoretical at any point between manholes, including receiving end, and plus or minus 1 1/2-inches in elevation from theoretical.

5. Pipe installed outside tolerances and subsequently abandoned shall first be fully grouted.

3.08 MONITORING

A. Instrumentation Monitoring and Surface Settlement Monitoring. Contractor shall reference Specification SS 02445 Settlement Monitoring.

3.09 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. Monitoring will be paid for a lump sum price for installations, observations, and reporting.

END OF SECTION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This section is intended to supplement SAWS Item 856 – Jacking, Boring or Tunneling Pipe. No modifications to Item 856 are proposed.

B. Section includes: Furnishing, installing, and monitoring settlement instrumentation for measuring ground movements around and above trenchless construction operations. The Work includes but is not limited to: installing surface monitoring points, installing subsurface monitoring points furnishing monitoring equipment, and recording observations and measurements from the monitoring points on a periodic basis before, during, and after trenchless construction.

C. The Contractor is responsible for surveying the elevations of the surface and subsurface monitoring points, in accordance with the requirements herein. Elevations shall be determined before operations begin to establish a baseline, and during and after operations to monitor any movements related to the trenchless construction. All monitoring points shall be surveyed after trenchless construction has been completed to evaluate long-term settlements, as specified herein.

D. Minimum instrumentation requirements are specified herein. Additionally, the Contractor shall install other instrumentation as necessary to control operations, monitor ground conditions and ground response to achieve specified project requirements and to prevent damage to existing structures and facilities.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02400 – Tunnel Shafts

B. SS 02314 – Tunneling with Liner Plate

C. SS 02441 – Pipe-Jacked Tunnels

D. SS 03360 – Contact Grouting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code or standard occur, the more restrictive specification shall govern. The latest edition available on the date of issue of Contract Documents shall be used.

B. San Antonio Water System (SAWS)

1. Specifications for Water and Sanitary Sewer Construction – latest version

2. Materials Specifications

1.04 DEFINITIONS

A. Surface Monitoring Points: A marking established as a baseline for measuring elevation of the ground surface using optical survey methods.

B. Subsurface Monitoring Point: A cased borehole settlement monitoring point located above the tunnel crown used for detecting settlement between the location of the settlement point and the tunnel excavation.

1.05 DESIGN CRITERIA

A. Any ground movements (settlement/heave) shall be limited to values that shall not cause damage to adjacent utilities and facilities that are to remain in service. In no case shall settlements exceed the applicable values listed in Table 1 below.

Table 1 – Maximum Allowable Settlement / Heave Values

Site Feature	Allowable Settlement / Heave (inches)
Railroad Tracks	0.25
Surface Streets	<0.5
Underground Utilities	<0.5
Unimproved Ground	3.00

1.06 QUALITY ASSURANCE

A. Surveyor Qualifications: All surveying shall be performed by a land surveyor licensed in the State of Texas with previous experience surveying for the detection of surface deformations.

B. Monitoring points shall be installed within 50 feet of the beginning and end of each tunnel as well as every 100 feet along the tunnel alignment. Also install monitoring points approximately 20 feet of each side of tunnel for primary lined tunnels greater than 60-inches. Additional surface monitoring points may be required and shall be installed as directed by SAWS.

C. Should actual field conditions prevent installation of instruments at the location specified herein, obtain written acceptance from SAWS for new instrument location and elevation.

D. Surveying for monitoring settlement instrumentation shall be referenced to the same control points and benchmarks established for setting out the Work. Control points shall be tied to benchmarks and other monuments outside of the zone of influence of the excavation or trenchless construction.

1.07 SUBMITTALS

A. Submittals shall be made in accordance with SAWS' requirements. Review and acceptance of the Contractor's submittals by the Consultant shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

B. Qualifications: Submit surveying personnel qualifications in accordance with the requirements herein.

C. Submit the following, at least one (1) month before scheduled installation of monitoring points:

1. Instrumentation Schedule: Submit the proposed schedule for installing the surface and subsurface monitoring points.

2. Description of methods and materials for installing and protecting surface and subsurface monitoring points.

3. Drawings with locations of proposed monitoring points shown in plan and profile.

D. Reports and Records

1. The Contractor shall submit all reports of monitoring data to SAWS.

2. Within 72 hours following installation of the instruments, submit drawings showing the actual as-built installed location, the instrument identification number, the instrument type, the installation date and time, and the tip elevation and instrument length. Include details of installed instruments, accessories and protective measures including all dimensions and materials used.

3. Submit surveyed baseline measurements of all monitoring points at least fourteen (14) days prior to commencing excavation to establish baseline readings.

4. Submit surveyed measurements of monitoring points during and after construction in accordance with Part 3 of this Specification.

E. Structure Assessment: Submit pre-construction and post-construction assessment reports for critical structures, namely those located within zone of active excavation from proposed tunnel centerline. Include photographs or videos of existing damage to structures in vicinity of sewer alignment in Assessment Report.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All instrumentation shall remain the property of the Contractor following completion of the Work and shall be removed or abandoned according to applicable codes and standards, unless otherwise noted.

B. Surface Monitoring Points: Surface monitoring points shall be established by an inscribed marking or approved surveyor's nail driven flush with the surface in asphalt or concrete paved areas. In landscaped areas, surface monitoring points shall be established by driving a 2-inch by 2-inch timber stake flush with the ground. The stake shall be driven to a depth required to provide a stable monitoring point given the soil conditions. Each monitoring point shall have a tag or marking indicating the station and offset from centerline.

C. Subsurface Monitoring Points: Each point shall consist of a #6 rebar settlement rod installed within and isolated from a PVC cased borehole. The settlement rod shall be driven 6 to 12 inches past the bottom of the borehole casing into undisturbed ground, and the tips shall be located at five feet above the pipe crown centerline as noted on the Plans, or as directed by the Consultant. The settlement rod shall be secured to the PVC casing with a 12-inch length of loose cable or chain to prevent the rod from falling more than approximately 12 inches. The casing shall be flush with pavement or recessed, and capped and protected with a road box if installed within traffic lanes, shoulders, parking lots, or bike lanes and shall be in accordance with applicable permit requirements.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. Instrumentation shall be installed at locations approved by SAWS. Instruments shall be installed in accordance with the approved installation schedule.

B. The Contractor shall locate conduits and underground utilities in all areas where borings are to be drilled and instruments installed. Instrument locations shall be modified, as approved by the Consultant, to avoid interference with the existing conduit and utilities. The Contractor shall repair damage to existing utilities resulting from instrument installations.

C. Contractor shall install and perform a baseline survey of all surface and subsurface settlement monitoring devices at least 14 days prior to excavation.

D. Contractor shall provide access and assistance to the Consultant for obtaining supplemental monitoring data, as requested by Consultant.

E. Provide data from readings of all monitoring points to the Consultant within 24 hours of reading.

3.02 MONITORING FREQUENCY

A. Surface Monitoring Points: Initial survey measurements shall be obtained prior to any excavation and daily after beginning excavation, or trenchless construction.

B. Subsurface Monitoring Points: Once trenchless construction begins, subsurface monitoring points within 50 feet of the tunnel face shall be surveyed once for every 10 feet of tunnel progress, and at least once daily.

C. All monitoring points shall be surveyed at least once per day during trenchless construction operations. Once these operations are complete, all settlement monitoring devices shall be surveyed once per day for the first seven days, once at 14 days, and once at 30 days after completion of the trenchless work.

D. Contractor to immediately report any movement, cracking, or settlement that approaches the allowable limits in paragraph 1.05.

3.03 SURFACE MONITORING POINTS

A. Establish a system of surface monitoring points. Up to eight (8) additional monitoring point locations (in addition to locations specified in Part 1.06) shall be determined jointly by SAWS and Contractor in the field prior to construction.

B. Surveying of surface monitoring points shall consist of determining the elevation of each monitoring point with respect to a benchmark selected by the Consultant to a precision of 0.01 foot.

3.04 SUBSURFACE MONITORING POINTS

A. Notify the Consultant at least 3 days in advance of installing subsurface monitoring points.

B. The subsurface monitoring points shall be installed as close as practicable to the locations approved by SAWS. SAWS may modify subsurface monitoring point locations depending on field conditions, conflicting utilities, and monitoring objectives.

C. Locate and confirm all utilities and protect utilities or relocate monitoring points as necessary to protect all utilities. Follow State laws and accepted industry procedures for one-call notification and visual confirmation of locations of all crossing or adjacent utilities.

D. Subsurface monitoring point installations shall be completed at least 14 days in advance of commencing shaft construction, or trenchless construction.

E. Conduct drilling operations using appropriate methods that are consistent with anticipated geologic conditions. Use mud rotary wash methods or provide casing as required to hold drill hole open.

F. Subsurface monitoring rods shall move freely with the soil at the tip and shall be isolated from the soil surrounding the borehole by the casing.

G. Establish monitoring points on all critical structures.

H. Protection: Install protective housing with cap. Protective housing shall be installed within a flush-mounted precast concrete box or vault if in traffic lanes or paved areas, so as not to obstruct vehicle or foot traffic, and shall be in accordance with TxDOT standards and permit requirements.

I. Surveying of subsurface monitoring points shall consist of determining the elevation of each monitoring rod with respect to a benchmark selected by the Consultant to a precision of 0.01 foot.

3.05 INSTRUMENT PROTECTION, MAINTENANCE, AND REPAIR

A. Protect the instruments and surface control points from damage. Damaged installations shall be replaced or repaired prior to continuing excavation, or trenchless construction, unless permitted otherwise in writing by the Consultant.

3.06 ABANDONMENT OF INSTRUMENTS

A. Surface Monitoring Points: All surface monitoring points on public property shall remain in place at the completion of the Work. Remove all surface monitoring points on private property during the cleanup and restoration work, or as required by SAWS.

B. Subsurface monitoring points: Properly abandon all monitoring point boreholes, by removing the rebar and then grouting the drilled holes with neat cement grout. Subsurface monitoring points shall be abandoned at the conclusion of the monitoring phase (See Paragraph 3.02 C) as described in 03360 – Contact Grouting, or as required by SAWS. Remove flush mounted surface boxes and restore surface to original condition.

PART 4 – PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. This item is considered subsidiary to the work and no separate payment will be made to the Contractor for the work.

END OF SECTION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This section is intended to supplement SAWS Item 856 – Jacking, Boring or Tunneling Pipe. No modifications to Item 856 are proposed.

B. The section provides the minimum requirements for manufacturing, furnishing, and transporting steel casing pipe to be installed by trenchless methods. The Contractor shall provide all labor, equipment and materials to install steel casing pipe to host water line and gravity sewer at the locations shown on the Plans.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02314 – Tunneling with Liner Plate

B. SS 02441 – Pipe-Jacked Tunnels

C. SS 02426 – Carrier Pipe in Tunnels

D. SS 03360 – Contact Grouting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code, or standard occur, the more restrictive specification shall govern. The latest edition available on the date of issue of Contract Documents shall be used.

B. San Antonio Water System (SAWS)

1. Specifications for Water and Sanitary Sewer Construction – latest version

2. Materials Specifications

C. ASTM A139 – Specification for Electric Fusion (Arc) Welded Steel Pipe (Sizes 4 inches and Over)

D. ASCE Standard Design and Construction Guidelines for Microtunneling ASCE/CI 36-14.

1.04 DEFINITIONS – Not Used

1.05 DESIGN CRITERIA

A. The Contractor is fully responsible for the design of steel casing pipe or tunnel liner that meets or exceeds the design requirements of this Specification and that is specifically designed for installation by the intended trenchless method.

B. Steel Casing Pipe

1. Design of the casing pipe shall account for all installation and service loads including: (1) jacking loads; (2) external groundwater and earth loads; (3) traffic loads, (4) practical consideration for handling, shipping, and other construction operations; (5) any other live or dead loads reasonably anticipated. Design shall be sealed and signed by a registered Professional Engineer licensed in the State of Texas. The Contractor shall submit certification that the design prepared by the Registered Engineer was used.

2. The allowable jacking capacity shall not exceed 50 percent of the minimum steel yield stress.

3. Steel casing pipe shall have a minimum wall thickness of 0.50 inches.

4. Steel casing pipe connections shall be achieved by full penetration field butt welding or an integral, machined, press-fit connection (Permalok or equal) prior to installation of the pipe, depending on the type of carrier pipe. Field butt welding a square end piece of steel pipe to a thirty-five (35) degree beveled end of steel pipe is acceptable. Integral, machined, press-fit connections shall be installed in accordance with the manufacturer's installation procedures and recommendations.

5. Steel casing pipe shall be provided with grout/lubricant ports along the pipe at intervals of ten (10) feet or less. Ports and fittings shall be attached to the pipe in a manner that will not materially affect the strength of the pipe nor interfere with installation of carrier pipe. Plugs for sealing the fittings shall be provided by the Contractor and shall be capable of withstanding all external and internal pressures and loads without leaking.

C. Steel casing pipe shall be provided with inside diameter sufficient to efficiently install the required carrier pipe with casing spacers as required in SS 02426 – Carrier Pipe in Tunnels. Allowable casing diameters are shown on the Plans.

D. Steel casing pipe shall be furnished in lengths that are compatible with Contractor's shaft sizes, allowable work areas and Contractor's approved work plan.

1.06 QUALITY ASSURANCE – Not Used

1.07 SUBMITTALS

A. Submittals shall be made in accordance with SAWS' requirements. Review and acceptance of the Contractor's submittals by the Consultant shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

B. Steel Casing Pipe: The Contractor shall furnish shop drawings illustrating the details of the casing pipe, grout/lubrication ports, joint details, and miscellaneous items to be furnished and fabricated for the pipe. Dimensions, tolerances, wall thickness, properties and strengths, and other pertinent information shall be shown. These items shall be submitted for review by SAWS prior to fabrication.

C. Calculations: Calculations shall be submitted in a neat, legible format. Basis of calculations shall be consistent with information provided in the Geotechnical Data Report. All calculations shall be prepared by or under direct supervision of a Professional Engineer licensed in State of Texas, who shall stamp and sign calculations.

1. Provide calculations confirming that pipe jacking capacity is adequate to resist the anticipated jacking loads for each crossing with a minimum factor of safety of two (2).

2. Submit calculations confirming that pipe capacity is adequate to safely support all other anticipated loads, including earth and groundwater pressures, surcharge loads, and handling loads.

3. Submit calculations confirming that jointing method will support all loading conditions.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Steel Casing Pipe

1. Steel casing pipe shall be new, smooth-wall, carbon steel pipe conforming to ASTM Specification A139, Grade B.

2. Dimensional Tolerances: Contractor shall bear sole responsibility for furnishing and installing steel casing pipe with dimensional tolerances that are compatible with performance requirements and proposed installation methods that meet or exceed the specific requirements below:

a. The minimum wall thickness at any point shall be at least 100% of the nominal wall thickness.

b. Steel pipe shall have an outside circumference that is within 1.0 percent or 3/4” of the nominal circumference, whichever is less.

c. The outside diameter of the pipe shall be within 1/8” of the nominal outside diameter.

d. Steel pipe shall have a roundness such that the difference between the major and minor outside diameters shall not exceed 0.5 percent of the specified nominal outside diameter or 1/4”, whichever is less.

e. Steel pipe shall have a maximum allowable straightness deviation of 1/8” in any 10- foot length.

f. All steel pipe shall have square ends. The ends of pipe sections shall not vary by more than 1/8” at any point from a true plane perpendicular to the axis of the pipe and passing through the center of the pipe at the end.

3. Steel casing pipe shall be fabricated with longitudinal weld seams. All girth weld seams shall be ground flush.

4. Prior to delivery of the pipe, end/internal bracing shall be furnished and installed, as recommended by the manufacturer, for protection during shipping, storage, and installation.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Steel casing pipe shall be installed in accordance with 02441 – Pipe-Jacked Tunnels.

B. Carrier pipe shall be installed inside steel casing pipe in accordance with 02426 – Carrier Pipe in Tunnels.

C. Contact grouting of the annulus outside the casing pipe shall be performed in accordance with 03360 – Contact Grouting.

PART 4 – PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. Casing pipe of the size and material required shall be measured for payment by the linear foot actually installed in accordance with the plans. Casing pipe shall be paid for under the bid item “Casing”.

END OF SECTION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This section is intended to supplement SAWS Item 856 – Jacking, Boring or Tunneling Pipe. No modifications to Item 856 are proposed.

B. This Section provides minimum requirements for contact grouting of all voids caused or encountered during casing installation, the annular space outside the jacking pipe after trenchless installations are complete, around shafts as necessary to prevent surface settlement, as necessary to complete portal stabilization work, and for abandonment grouting of boreholes for subsurface monitoring points after trenchless construction is complete.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. SS 02400 – Tunnel Shafts

B. SS 02314 – Tunneling with Liner Plate

C. SS 02315 – Portal Stabilization

D. SS 02441 – Pipe-Jacked Tunnels

E. SS 02426 – Carrier Pipe in Tunnels

F. SS 02445 – Settlement Monitoring

G. SS 02610 – Steel Casing Pipe

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code, or standard occur, the more restrictive specification shall govern. The latest edition available on the date of issue of Contract Documents shall be used.

B. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field

C. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

D. ASTM C 94 – Standard Specification for Ready-Mixed Concrete

E. ASTM C 109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch Cube Specimens)

F. ASTM C 144 – Standard Specification for Aggregate for Masonry Mortar

G. ASTM C 150 – Standard Specification for Portland Cement

H. ASTM C 937 – Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete

1.04 DEFINITIONS – Not Used

1.05 DESIGN CRITERIA

A. Contact grout shall be used to fill any voids, including the annular space created by the shield overcut during trenchless construction, caused or encountered outside of shafts, as necessary for portal stabilization, and for abandonment of subsurface monitoring point boreholes.

B. Grout Mixes: Develop one or more grout mixes designed to completely fill the voids outside the casing or shafts and to provide acceptable strength to prevent settlement. Grout used outside shaft excavations shall be of a strength that allows for efficient excavation by the tunneling equipment. Determine 24-hour and 28-day strength of each grout mix in accordance with ASTM C39 or C109. All grout mix proportions shall be subject to review and acceptance by the Consultant.

C. Grout Composition: Grout shall consist of Portland cement, bentonite, fluidifier as necessary, and water in the proportions specified herein or as approved by the Consultant. Sand may be added to the grout mix in instances of very high grout takes as approved by the Consultant. The addition of sand may require additional water or fluidifier to be added to the grout mix.

D. Compressive Strength: The minimum compressive strength at 24 hours shall be at least 10 psi. The minimum compressive strength at 28 days shall be 50 psi. The grouting contractor shall coordinate with the trenchless subcontractor to ensure that the grout strength for any grout that will be excavated during trenchless construction can be efficiently excavated by the tunneling equipment without damaging the equipment or causing excessive wear of cutting tools.

1.06 QUALITY ASSURANCE

A. Grout Strength Tests:

1. Prepare samples for 24-hour and 28-day compressive strength tests according to ASTM C31 for cylinders or ASTM C109 for cubes. Test samples according to ASTM C39 or C109 as applicable. Grout for the cylinders or cubes shall be taken from the nozzle of the grout injection line. Collect at least one set of four (4) samples for each 500 cubic feet of grout injected but not less than one set for each grouting shift, unless directed in writing otherwise by the Consultant.

1.07 SUBMITTALS

A. Submittals shall be made in accordance with SAWS' requirements. Review and acceptance of the Contractor's submittals by the Consultant shall not be construed in any way as relieving the Contractor of its responsibilities under this Contract.

B. Work Plan and Methods:

1. Submit a work plan for each type of contact grouting required, including: contact grouting methods and details of equipment, grouting procedures and sequences, injection pressures, monitoring and recording equipment, pressure gauge calibration data, methods of controlling grout pressure, and provisions to protect pipe lining or shaft supports.

2. Submit details of grout mix proportions, admixtures, including manufacturer's literature, MSD sheets, and laboratory test data verifying the strength of the proposed grout mix.

C. Reports and Records: Maintain and submit daily logs of grouting operations, including grouting locations, pressures, volumes, and grout mix pumped, and time of pumping. Note any problems or unusual observations on logs.

D. Grout Strength Tests: Submit test results for 24-hour and 28-day compressive strength tests for the cylinder molds or grout cubes obtained during grouting operations.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Cement: Cement shall be Type II or Type V Portland cement conforming to ASTM C 150. Type II cement shall meet Table 4 false set requirements of ASTM C 150.

B. Bentonite: Bentonite shall be a commercially processed powdered bentonite, Wyoming type, such as Imacco-gel, Black Hills, or equal.

C. Fluidifier: Fluidifiers shall hold the solid constituents of the grout in colloidal suspension, be compatible with the cement and water used in the grouting work, and comply with the requirements of ASTM C 937.

D. Admixtures: Other admixtures may be used subject to the written approval of SAWS to improve the pumpability, to control set time, to hold sand in suspension, and to prevent segregation and bleeding.

E. Water: Requirement such as pH level per ASTM C94.

2.02 EQUIPMENT

A. Equipment for mixing and injecting grout shall be adequate to satisfactorily mix and agitate the grout and force it into the grout ports, in a continuous flow at the desired pressure. Pumps shall be capable of continuously developing a sustained pressure of 0.5 psi per foot of overburden at the grout port connection. Sustained grouting pressures shall not exceed 0.5 psi per foot of overburden unless otherwise approved by SAWS.

B. Two pressure gauges shall be provided, one at the grout pump and one at the collar of each port being grouted. The accuracy of the gauges shall be periodically checked with an accurately calibrated pressure gauge. A minimum of two spare pressure gauges shall be available on site at all times.

C. The grouting equipment shall be provided with a meter to determine the volume of grout injected. The meter shall be calibrated in cubic feet to the nearest one-tenth of a cubic foot.

D. The grouting equipment shall be maintained in satisfactory operating condition throughout the course of the work to ensure continuous and efficient performance during grouting operations.

E. Suitable stop valves shall be provided at the collar of each port for use in maintaining pressure as required until the grout has set.

F. Grout hoses shall have an inside diameter not less than 1-1/2 inches and shall be capable of withstanding the maximum water and grout pressures to be used.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. All grouting operations are to be performed in the presence of SAWS. Notify SAWS at least 24 hours in advance of starting contact grouting operations.

B. The Contractor shall take care to prevent the spill or escape of grout to the ground surface, into any water body, or into any sanitary or storm sewer. The Contractor shall closely monitor grouting operations to detect any spills or escape of grout to the surface or into any water body, sanitary sewer, or storm sewer. Any such spill shall be immediately contained and cleaned up by the Contractor at no additional cost.

C. During grouting work, provide for adequate disposal of all waste and wastewater. Remove and properly dispose of all waste grout resulting from grouting operations. The contents of grout lines shall not be discharged into the pipe, sanitary sewers, storm drains, or water bodies.

3.02 MIXING AND INJECTION OF GROUT

A. All materials shall be free of lumps when put into the mixer and the grout mix shall be continuously agitated. Grout shall flow unimpeded and shall completely fill all voids. Grout not injected within 90 minutes of mixing shall be wasted.

B. The grouting process shall be operated and controlled so that the grout is delivered uniformly and steadily.

C. Recirculate grout mixes when any new mix is batched or after adding water, fluidifier, or sand to mix. Recirculate mix for at least 2 minutes prior to pumping grout into grout port.

D. In general, grouting will be considered completed when less than one cubic foot of grout of the accepted mix and consistency can be pumped in 5 minutes under the specified maximum pressure. After the grouting is finished, the valve shall be closed before the grout header is removed and remain closed until grout has set. For any port ahead of the grouting operation, with a valve attached, and the valve in the open position; the current port shall be considered grouted if grout issues forth, from the subsequent port, with the same color and consistency, and at the same rate as that being pumped. Replace grout plugs in pipe at the completion of grouting.

3.03 CONTACT GROUTING OF SHAFTS

A. Commence contact grouting of shafts after completion of each shaft, and before trenchless construction begins.

B. Inject grout through vertical or inclined holes drilled from the ground surface to intersect the known or suspected void. Alternatively, drill grout holes horizontally through shaft support elements into the soil to intersect the known or suspected void. Holes shall be sufficiently close to ensure all voids are completely filled.

C. Install check valve and grout nipple in each hole drilled.

D. Inject grout through each grout nipple until completion, as defined in Paragraph 3.02 D.

3.04 CONTACT GROUTING OF STEEL CASING

A. Commence contact grouting outside of the casing pipe within 72 hours following the completion of each drive.

B. Grout ports shall be provided in casing pipes at intervals not greater than 10 feet.

C. Contact grout ports shall be installed by the pipe manufacturer in the pipe before pipe is jacked into place. Drilling grout ports through pipe shall not be permitted. Grout ports shall be threaded to accept valve fittings and plugs.

D. An attempt shall be made to hook-up and pump grout at every port or coupling unless approval is granted by SAWS in writing to omit grouting of selected ports.

E. Before attempting to grout a port the Contractor shall insert a long rod through the port to clean the area outside the grout port of loose soil and to provide a path for grout to travel.

F. Inject grout through the grout connections in such a manner as to completely fill all voids outside the pipe resulting from, or encountered during, trenchless operations. Grout pressure shall be controlled to avoid damaging the pipe, and to avoid movement of the surrounding ground or improvements.

G. Grouting shall generally progress sequentially in a constant upgradient direction from one grout port to the next grout port in the sequence indicated in the approved submittals.

H. At all times during the grouting operations, sufficient contact grout ports ahead of the port to be grouted shall be cleaned and ready for grouting. Valves or other suitable devices shall be attached and placed in the fully open position on all ungrouted ports within the maximum grout communication distance, as determined by the Contractor and accepted by the Consultant.

I. For any port ahead of the grouting operation, with a valve attached, and the valve in the open position, such port shall be considered grouted if grout issues forth of the same consistency and color, and at the same rate as that being pumped. Replace grout plugs in pipe at the completion of grouting.

J. Pipe grout fittings shall be sealed with screw type plugs upon completion of grouting.

3.05 CONTACT GROUTING OF SUBSURFACE SETTLEMENT POINT BOREHOLES

A. After all settlement monitoring measurements have been completed, monitoring point borehole casings shall be grouted.

B. Inject grout into each casing until filled. Grout may be injected by gravity flow, through a tremie pipe, or by attaching a valve and nipple at the casing collar.

3.06 CLEANUP

A. After completion of contact grouting, all related construction debris, grout, oil, grease, and all other materials shall be removed from the jacking pipe, jacking and receiving shafts, and all Contractor work areas.

PART 4 – PAYMENT

4.01 MEASUREMENT FOR PAYMENT

A. This item is considered subsidiary to the work and no separate payment will be made to the Contractor for the work.

END OF SECTION