TECHNICAL SPECIFICATIONS
FOR CONSTRUCTION OF

PURLSONG WASTEWATER TREATMENT FACILITY
LIFT STATION

FOR

PURLSONG MUNICIPAL MANAGEMENT

DISTRICT OF COMAL COUNTY

NOVEMBER 2025

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APPENDIX A GEOTECHNICAL ENGINEERING STUDY FOR LIFT STATION AND WASTEWATER TREATMENT FACILITY NB WEST, NEW BRAUNFELS, TEXAS

DESIGN PROFESSIONAL OR AREAS OF RESPONSIBILITY

The following specifications were prepared by me or under my direction:

Jessica Simpson
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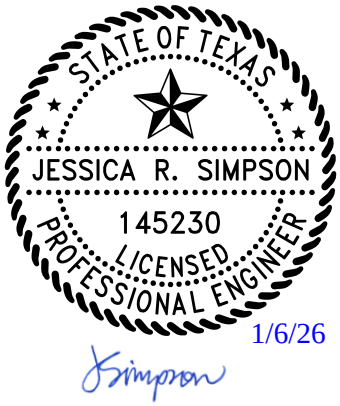

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PAPE–DAWSON

DESIGN PROFESSIONAL OR AREAS OF RESPONSIBILITY

The following specifications were prepared by Pape-Dawson under my direction:

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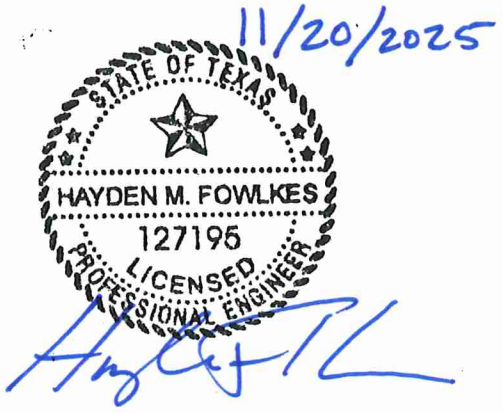

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SECTION 01 10 00 – PROJECT SUMMARY

PART 1 – GENERAL

1.1 CONTRACT DESCRIPTION

A. Work includes the construction of the Purlsong Wastewater Treatment Facility (WWTF) Lift Station to accommodate temporary pump and haul operations. The furnishing and installation of the submersible pumps, hoist, level transducer, float switches, electrical work, and WWTF components will be completed later under a separate contract. The work for the general contractor includes, but is not limited to the furnishment and installation of the following items (as shown on the Plans and specified herein):
   1. 10-foot diameter pre-cast concrete wet well
   2. Top and bottom wet well slabs
   3. Discharge elbows, piping, pipe supports, valving, and fittings
   4. Lift Station appurtenances
   5. Access Road (to WWTF site) and Access Driveway within WWTF site
   6. Site Fencing
   7. Site Civil/Grading and Yard Piping

B. Perform Work under Contract with Owner according to Conditions of Contract.

1.2 WORK BY OWNER OR OTHERS

A. Coordinate Work with utilities of Owner.

1.3 OWNER-FURNISHED PRODUCTS

A. Owner's Responsibilities:
   1. Arrange for and deliver Owner-reviewed Shop Drawings, Product Data, and Samples to Contractor.
   2. Arrange and pay for delivery to Site.
   3. Upon delivery, inspect products jointly with Contractor.
   4. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
   1. Review Owner-reviewed Shop Drawings, Product Data, and Samples.
   2. Receive and unload products at Site; inspect for completeness or damage jointly with Owner.
   3. Handle, store, install and test equipment.
   4. Repair or replace items damaged after receipt.

1.4 CONTRACTOR'S USE OF SITE AND PREMISES

A. Limit use of Site and premises to allow:

1. Owner occupancy.

B. Construction Operations: Limited to areas indicated on Drawings.

C. Time Restrictions for Performing Work: Daylight Hours.

D. Utility Outages and Shutdown:
1. Coordinate and schedule electrical and other utility outages with Owner.
2. Outages: Allowed only at previously agreed upon times.
3. At least one week before scheduled outage, submit Outage Request Plan to Architect/Engineer itemizing the dates, times, and duration of each requested outage.
4. Existing treatment system will not be allowed to be out of service longer than the equalization storage capacity at the time of the requested outage.

E. Sound Level Restrictions: Sound pressure level measured at boundary of Site shall not exceed: Not applicable.

F. Construction Plan: Before start of construction, submit three copies of construction plan regarding access to Work, use of Site, and utility outages for acceptance by Owner. After acceptance of plan, construction operations shall comply with accepted plan unless deviations are accepted by Owner in writing.

G. Coordinate use of premises with Owner.

H. The contractor shall assume full responsibility for the security of all his/her and his/her subcontractors' materials and equipment stored on the site.

I. If directed by the Owner, move any stored items that interfere with operations of Owner, operator or other contractors.

J. Obtain and pay for use of additional storage or work areas if needed to perform the Work.

K. Contractor shall submit to the Owner for approval a plan of operations, designating proposed areas of the property to be used for his operations, material storage, equipment storage, employee's parking, offices, and shops.

L. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials, or equipment, shall be repaired, or corrected at the sole expense of the Contractor.

M. Any fence that is damaged or removed by the Contractor shall be replaced at the Contractor's expense in like kind, and to the satisfaction of the Engineer.

1.5 WORK SEQUENCE

A. Contractor shall construct Work to accommodate Owner's occupancy requirements during construction period. Coordinate construction schedule and operations with Owner.

B. Sequencing of Construction Plan: Before start of construction, submit three copies of construction plan regarding phasing of Work for acceptance by Owner. After acceptance of plan, construction sequencing shall comply with accepted plan unless deviations are accepted by Owner in writing.

C. Other variations of the sequence of work are possible. It is the Contractor's responsibility to develop a final sequence of work and project schedule. The final schedule shall also meet project Substantial and Final Completion dates as required by the General Conditions.

1.6 OWNER OCCUPANCY

A. Schedule the Work to accommodate Owner occupancy.

1.7 PERMITS

A. Furnish necessary permits for construction of Work.

1.8 CONNECTIONS TO EXISTING FACILITIES

A. Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities including tanks, drain lines, and utilities. In each case, Contractor shall notify Owner's Representative three weeks prior to any shutdowns or tie-ins. Notice shall include written procedure describing all aspects of work, including but not limited to materials, safety, confined space entry, time to complete, and cure time, as applicable. Contractor shall receive written permission from the Owner's Representative prior to undertaking connections. Contractors shall protect facilities against deleterious substances and damage.

B. Connections to existing facilities which are in service shall be thoroughly planned and all required equipment, materials and labor shall be on hand at the time of undertaking the connection. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Operation of valves or other appurtenances on existing utility, when required, shall by or under the direct supervision of the operations staff or Owner's representative.

END OF SECTION 01 10 00

SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Coordination and Project conditions.

B. Preconstruction meeting.

C. Site mobilization meeting.

D. Progress meetings.

E. Pre-Installation meetings.

F. Closeout meeting.

G. Alteration procedures.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various Sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify that utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
   1. Coordination Drawings: Prepare as required to coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important.

D. Coordination Meetings: In addition to other meetings specified in this Section, hold coordination meetings with personnel and Subcontractors to ensure coordination of Work.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within

construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion.

G. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

1.3 PRECONSTRUCTION MEETING

A. Engineer will schedule and preside over meeting after Notice of Award.

B. Attendance Required: Engineer, Owner, Resident Project Representative, appropriate governmental agency representatives, major Subcontractors, and Contractor.

C. Minimum Agenda:
1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of Subcontractors, list of products, schedule of values, and Progress Schedule.
5. Designation of personnel representing parties in Contract, Owner and Engineer.
6. Communication procedures.
7. Procedures and processing of requests for interpretations, field decisions, field orders, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.
9. Critical Work sequencing.
10. Scheduling activities of Special Inspector.

D. Engineer: Record minutes and distribute copies to participants within five days after meeting, to Contractor, Owner, and those affected by decisions made.

1.4 PROGRESS MEETINGS

A. Engineer shall schedule and administer meetings throughout the progress of the Work at maximum monthly intervals.

B. Engineers will plan for meetings, prepare agenda with copies for participants, and preside over meetings.

C. Attendance Required: Job superintendent, major Subcontractors Contractors and suppliers, and

Engineer, Owner, as appropriate to agenda topics for each meeting.

D. Minimum Agenda:
   1. Review minutes of previous meetings.
   2. Review of Work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems impeding planned progress.
   5. Review of submittal schedule and status of submittals.
   6. Review of off-Site fabrication and delivery schedules.
   7. Maintenance of Progress Schedule.
   8. Corrective measures to regain projected schedules.
   9. Planned progress during succeeding work period.
   10. Coordination of projected progress.
   11. Maintenance of quality and work standards.
   12. Effect of proposed changes on Progress Schedule and coordination.
   13. Other business relating to Work.

E. Engineer Record minutes and distribute copies to participants within five days after meeting, to Contractor, Owner, and those affected by decisions made.

1.1 PREINSTALLATION MEETINGS

A. When required in individual Specification Sections, convene preinstallation meetings at Project Site before starting Work of specific Section.

B. Require attendance of parties directly affecting, or affected by, Work of specific Section.

C. Notify Engineer four days in advance of meeting date.

D. Prepare agenda and preside over meeting:
   1. Review conditions of installation, preparation, and installation procedures.
   2. Review coordination with related Work.

E. Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

1.5 CLOSEOUT MEETING

A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meetings and be responsible for minutes.

B. Attendance Required: Contractor, major Contractors major Subcontractors, Engineer, Owner, and others appropriate to agenda.

C. Notify Engineer four days in advance of meeting date.

D. Minimum Agenda:
   1. Start-up of facilities and systems.
   2. Operations and maintenance manuals.
   3. Testing, adjusting, and balancing.
   4. System demonstration and observation.
   5. Operation and maintenance instructions for Owner's personnel.
   6. Contractor's inspection of Work.
   7. Contractor's preparation of an initial "punch list."
   8. Procedure to request Engineer inspection to determine date of Substantial Completion.
   9. Completion time for correcting deficiencies.
   10. Inspections by authorities having jurisdiction.
   11. Certificate of Occupancy and transfer of insurance responsibilities.
   12. Partial release of retainage.
   13. Final cleaning.
   14. Preparation for final inspection.
   15. Closeout Submittals:
      a. Project record documents.
      b. Operating and maintenance documents.
      c. Operating and maintenance materials.
      d. Affidavits.
   16. Final Application for Payment.
   17. Contractor's demobilization of Site.
   18. Maintenance.

E. Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

PART 3 – EXECUTION

3.1 ALTERATION PROCEDURES

A. Entire facility will be occupied for normal operations during the progress of construction. Cooperate with Owner in scheduling operations to minimize conflict and to permit continuous usage.
   1. Perform Work not to interfere with operations of occupied areas.
   2. Keep utility and service outages to a minimum and perform only after written approval of Owner.
   3. Clean Owner-occupied areas daily. Clean spillage, overspray, and heavy collection of dust immediately.

B. Materials: As specified in product Sections; match existing products with new products for patching and extending Work.

C. Employ skilled and experienced installer to perform alteration and renovation Work.

D. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion. Comply with Section 01 70 00 - Execution and Closeout Requirements

E. Remove unsuitable material not marked for salvage, including rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.

F. Remove debris and abandoned items from area and from concealed spaces.

G. Prepare surface and remove surface finishes to permit installation of new Work and finishes.

H. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity.

I. Remove, cut, and patch Work to minimize damage and to permit restoring products and finishes to specified condition.

J. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.

K. Where new Work abuts or aligns with existing Work, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

L. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and submit recommendation to Architect/Engineer for review.

M. Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing other imperfections.

N. Finish surfaces as specified in individual product Sections.

END OF SECTION 01 30 00

SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. Gannt chart schedules.

D. Review and evaluation.

E. Updating schedules.

F. Distribution.

1.2 SUBMITTALS

A. Submit schedules under transmittal letter form specified in Section 01 33 00 - Submittal Procedures.

B. Schedule Updates:
   1. Overall percent complete, projected, and actual.
   2. Completion progress by listed activity and sub-activity, to within five working days prior to submittal.
   3. Changes in Work scope and activities modified since submittal.
   4. Delays in submittals or resubmittals, deliveries, or Work.
   5. Adjusted or modified sequences of Work.
   6. Other identifiable changes.
   7. Revised projections of progress and completion.

C. Narrative Progress Report:
   1. Submit each monthly submission of Progress Schedule.
   2. Summary of Work completed during the past period between reports.
   3. Work planned during the next period.
   4. Explanation of differences between summary of Work completed and Work planned in previously submitted report.
   5. Current and anticipated delaying factors and estimated impact on other activities and completion milestones.
   6. Corrective action taken or proposed.

1.3 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel specializing in scheduling with two years' minimum experience in scheduling construction work of complexity comparable to the Project and having use of computer facilities capable of delivering detailed graphic printout within 48 hours of request.

B. Contractor's Administrative Personnel: Two years' minimum experience in using and monitoring schedules on comparable Projects.

1.4 GANTT CHART SCHEDULES

A. Format: Gantt Chart Schedule, to include at least:
   1. Identification and listing in chronological order of those activities reasonably required to complete the Work, including:
      a. Subcontract Work.
      b. Other Contractor Work.
      c. Major equipment design, fabrication, factory testing, and delivery dates including required lead times.
      d. Mobilization and other preliminary activities.
      e. Equipment and equipment system test and startup activities.
      f. Project closeout and cleanup.
      g. Work sequences, constraints, tasks and milestones.
   2. Identification of the following:
      a. Horizontal time frame by year, month, and week.
      b. Duration, early start, and completion for each activity and sub activity.
      c. Critical activities and Project float.
      d. Sub schedules to further define critical portions of Work.

1.5 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of schedules with Architect/Engineer at each submittal.

B. Evaluate Project status to determine Work behind schedule and Work ahead of schedule.

C. After reviewing schedules incorporating results of review and resubmit within 10 days.

1.6 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each

activity. Annotate schedules to depict status of Work.

C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

D. Upon approval of a Change Order, include the change in the next schedule submittal.

E. Indicate changes required to maintain Date of Substantial Completion.

F. Submit shorts as required to support recommended changes.

G. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate Contractors.

1.7 DISTRIBUTION

A. Following joint review, distribute copies of updated schedules to Contractor's Project site file, to Subcontractors, suppliers, Engineer, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

END OF SECTION 01 32 16

SECTION 01 32 33 - CONSTRUCTION PHOTOGRAPHS

PART 1 – GENERAL

1.1 SUMMARY

A. CONTRACTOR shall be responsible for producing construction photographs and video documentation as provided herein.

1.2 SUBMITTALS

A. See Section 01 33 00.

B. Provide thumb drive containing digital photographs of entire project after completion. Each thumb drive shall be marked with the name and number of contracts, name of CONTRACTOR, description, and location of photograph.

1.3 QUALITY

A. All photographs shall be digital quality of 3.2 megapixel or higher resolution.

B. All copyrights or other restrictions on the use of all photographic prints or digital source files shall be released to the OWNER so that the OWNER may reproduce, modify, and/or publish photographs in any form or medium.

1.4 VIEWS AND QUANTITIES

A. Each month, an average of 100 exposures shall be taken as directed by Owner's Representative. Plan a minimum of five photos per day.

B. Proof of all exposure, in digital format on drive, shall be promptly furnished to the Owner's Representative at the end of each month. The Owner's Representative shall select an average of twenty exposures per month to be submitted as described under Products.

1.5 PRE-CONSTRUCTION PHOTOGRAPHS

A. Preconstruction photos recording of the entire project site, access points, perimeter

fencing, features adjacent to the site and access roads shall be required.

B. A minimum of 20 photos shall be taken prior to any work being done. These photos will be taken at all areas and surrounding areas where construction will take place.

1.6 FINAL PHOTOGRAPHS

A. All photos that were taken at the beginning (pre-construction) shall be taken after all work (including re-vegetation) has been completed.

PART 2 - EXECUTION

2.1 EXECUTION

A. These photographs shall be submitted with the CONTRACTOR'S application for progress payment.

B. The photographs shall present important factual details with high resolution, minimum distortion and maximum depth-of-field and sharpness. Views shall adequately illustrate project status or condition of construction.

C. CONTRACTOR shall perform preconstruction photos and submit OWNER's copy before any equipment, materials, or forces have been mobilized to the site.

D. OWNER's Representative shall accompany CONTRACTOR during the preconstruction photography.

E. Intent is to document preconstruction condition of existing features.

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTALS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK:

This section describes the requirements for preparing and presenting submittals that are necessary for the execution of this contract. Requirements within the following subject areas are included:

A. Definitions

B. Procedures

C. Product Data

D. Shop drawings

E. Samples

F. Manufacturer's certificates

1.2 DEFINITIONS:

A. Product Data and Shop Drawing, General Definition
Drawings, diagrams, illustrations, brochures, schedules, bills of materials and other data prepared by the CONTRACTOR, his subcontractors, suppliers or distributors, or equipment manufacturers and fabricators; illustrating the manufacture, fabrication, construction, or installation of the Work or a portion thereof.

B. Shop Drawings
Assembly and fabrication drawings, bills of materials for items shop fabricated exclusively for this project. In addition, shop drawings should show fabrication details of each part, the assembly of each part and how each part and/ or assembly is integrated into the project including existing parts or assemblies.

C. Manufacturer's Representative
A representative from the manufacturer's plant with 5 years of experience in the actual problems of manufacturing, installing and operating the particular product. Sales representatives or agents of the manufacturer will not be acceptable.

D. Working Drawings
CONTRACTOR-prepared plans for temporary structures and facilities. Working drawings for elements of work that may affect the safety and health of persons or

property will be certified by an engineer licensed in the state of Texas. Calculations, as necessary, will accompany working drawings.

PROCEDURES:

A. CONTRACTOR's Responsibilities
   1. Submit a schedule of specified submittals for all materials to be installed for the Project to the Engineer within 14 calendar days of receipt of the notice to proceed.
   2. Submissions will be made to the Engineer and GBRA via email in .pdf format. Data and correspondence that originates with subcontractors and suppliers must be submitted to the Engineer through the CONTRACTOR. CONTRACTOR to approve all submittals prior to submission.
   3. The CONTRACTOR will submit dimensional and layout drawings and product data, certified correct for construction, for review by the Engineer.
   4. Submit shop drawings and product data in accordance with the approved submittal schedule. Also submit shop drawings to the Engineer for review prior to their need in the Work, allowing sufficient time for the Engineer's review and response.
      a. As requested by GBRA, the engineer shall provide one copy of each submittal to GBRA for their review and comment. GBRA requires 21 days for review.
      b. The CONTRACTOR shall limit each submittal to only one specification section.
   5. The CONTRACTOR will make specific mention of those items that vary from the requirements of the Plans and Specifications. List any proposed deviations on the submittal cover sheet. Deviations will not be allowed without specific written approval from the Engineer.
   6. Submit shop drawings and product data covering related items of equipment or material or integrated systems of equipment or material at the same time. Partial submissions will not be accepted.
   7. The CONTRACTOR will coordinate shop drawings and product data with drawings previously submitted, with drawings being prepared, and with drawings and data previously approved. All such coordination shall be indicated by reference.
   8. The CONTRACTOR will assign a sequential number to each submittal (01, 02, 03, etc.). The CONTRACTOR shall assign each piece of material or equipment its own submittal number. Multiple items under the same submittal number will not be accepted. Re-submittals will be identified with their original number followed by a sequential letter (A (original submittal), B (first resubmittal), C (second resubmittal), etc.). For example, submittal 11510-12-C is the third submittal of the twelfth item submittal in Section 11510.
   9. The CONTRACTOR shall not order, fabricate, or deliver to the site, storage, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.

B. Engineer's Review:
   1. The Engineer will conduct a review after its receipt in the Engineer's office so as not to create delay. This review will be for general conformance, subject to the requirements of the Contract Documents, and will be an effort to assist the

CONTRACTOR to discover errors and omissions in submittals.

2. Engineer's review or other appropriate action regarding CONTRACTOR's submissions will be only to check conformity with the design concept of the Project and for compliance with the information contained in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Plans and Specifications) or to safety precautions or programs incident thereto. The review and approval of a separate component item will not indicate approval of the assembly into which the item is functionally integrated. CONTRACTOR shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings to the Engineer. CONTRACTOR may be required to resubmit as required revised Shop Drawings or Samples for further review and approval. CONTRACTOR shall direct specific attention in writing to any new revisions not specified by CONTRACTOR on previous CONTRACTOR submissions.
3. The Engineer's review does not relieve the CONTRACTOR of the obligation and responsibility to coordinate the Work and plan the details of the Work and does not relieve the CONTRACTOR from the duty to comply with the contract documents.
4. The Engineer reserves the right to require written confirmation from the CONTRACTOR that the comments placed on submittals stamped "Reviewed" will be implemented.
5. Review by the Owner or Engineer will not be construed as relieving the CONTRACTOR of the responsibility for the accuracy, proper fit, functioning, or performance of the Work.

1.2 PRODUCT DATA:

A. Product data, including materials reproduced from manufacturer's product catalogs, will not be larger than 8½" by 11" in size.

B. Catalog data will be explicit with regard to the name of the manufacturer and to the details of the products being furnished. It will also be complete enough to enable the

Engineer to determine that the products being submitted conform to the requirements of the specifications.

C. For submittals with more than one style or size of a product on a sheet, the CONTRACTOR will clearly indicate which product is being submitted for review. Use clouds, boxes, arrows, etc., to clearly mark all proposed options and part numbers.

D. The CONTRACTOR will submit three (3) copies of all product data to the Engineer, and one (1) electronic copy (.pdf).

1.3 SHOP DRAWINGS:

A. The CONTRACTOR shall reasonably check and verify all field measurements prior to submitting and will submit to the Engineer for review and approval. These shop drawings will bear a stamp from the CONTRACTOR that indicates that the

CONTRACTOR has reviewed the shop drawings and that the submittal is complete and in compliance with Contract Documents.

B. The CONTRACTOR will submit detailed drawings and descriptions of proposed deviations from details or component arrangement indicated on the Plans.

C. Single line drawings will not be acceptable. Copies of the Plans will not be accepted for submission as drawings, nor will catalog numbers alone of materials or equipment.

D. The CONTRACTOR will submit three (3) copies of each shop drawing to the Engineer for review and one (1) electronic copy (.pdf). GBRA requires a PDF copy.

E. In lieu of 1.05 D, the CONTRACTOR may provide submittals in electronic form (.pdf) emailed to the Engineer and GBRA.

1.4 SAMPLES

The CONTRACTOR will furnish samples of items and materials as required. Samples shall be submitted to the Engineer in duplicate. Each sample will be properly labeled and identified by providing the following:

A. Date

B. Job name for which it is offered

C. Specification section and paragraph

D. CONTRACTOR’s name

E. Supplier and trade name

F. Other data indicating conformance to specifications.

1.5 MANUFACTURER'S CERTIFICATES AND AFFIDAVITS:

Where specified in the Plans and Specifications that a certificate and affidavit shall be submitted to the Engineer for review of a particular product, or component of a product, such submittals shall be made in accordance with the following:

A. A certificate submitted for a product, or component of a product, indicates test results proving that product, or component of a product, meets the requirements of the standard specified in the Plans and Specifications.

B. An affidavit consisting of a sworn statement by an official of the company manufacturing the product indicating that the information on the certificate is true and accurate shall accompany the certificate.

C. A statement from the CONTRACTOR, or his subcontractors, suppliers, or other agent which indicates that a particular item of equipment, or product, or component of a

product, meets the requirements of the Plans and Specifications shall not be considered as certificate and will not be approved.

1.6 MANUFACTURER'S REPRESENTATIVE

The CONTRACTOR will include in the contract price the cost of furnishing competent and experienced manufacturer's representatives to represent the manufacturer on all products furnished and to assist the CONTRACTOR to install the products in conformity with the Plans and Specifications.

1.7 MISCELLANEOUS SUBMISSIONS:

A. Work plans – submit 2 copies

B. Accident reports – 2 copies

C. Inspection and test reports – 2 copies

D. Guarantees and Warranties – 2 copies (Originals), valid for 1 year from date of project final acceptance. Warranty shall include parts and labor for removal, repair, and replacement.

E. Operation and Maintenance Manuals - Provide three (3) hard copies and three (3) CD/PDF searchable electronic copies of each O&M manual. Hard copies shall be printed duplex 8.5" x 11" in color on 24# bound paper with reinforced holes and bound in D-ring binders (maximum 4" binders per volume) with sheet lifters front and back, table of contents, and tabbed sections. Drawings and schematics shall be 11" x 17" and z-folded. Include test reports and calibration certificates. O&M description, project name, contractor name, and specification section shall be printed on the spine and cover of each binder. All copies shall be manufacturer original quality. Scanned and/or photocopies are not acceptable. Submit electronic preliminary copies for GBRA review and approval prior to printing final copies. Submit at least two (2) weeks prior to operator training.

F. Course of Action Plan (Fuel Spill or Other Substances)
   1. The CONTRACTOR must submit the Course of Action Plan (Fuel Spill or Other Substances) to the Owner prior to start of construction.
   2. With regard to the accidental spill of fuel the Plan must address the procedures required by applicable regulations and laws.

G. Copies of all closeout submittals required by regulatory agencies (city, county, TCEQ, etc.).

H. Spare Parts: Provide a spare part for each single point of failure item. Provide one (1) change of lubricants and filters for each piece of equipment.

I. Provide CD backup copies of programming for PLC's, pump controllers, HMI and control room(s).

J. Waiver of lien by CONTRACTOR (and Subcontractors), as appropriate.

K. Executed operating contract or bill of sale transferring facility to the GBRA.

L. As-Builts: CONTRACTOR to submit one (1) preliminary electronic copy of as-builts to GBRA for review and approval prior to printing final copies. Upon preliminary approval, CONTRACTOR shall submit one (1) printed and bound full-sized copy of red-lined as-built drawings and one (1) CD/PDF electronic copy, each sheet stamped "as-built drawing."

PART 2 – PRODUCTS (Not used)

PART 3 – EXECUTION

3.1 SUBMITTAL COVER

A. See Section 01 33 00.10 Submittal Cover.

END OF SECTION 01 33 00

Shop Drawing Transmittal No. _____

Project Name:		Date to Engineer:	
Project Owner:		Reviewed By:	
Contractor:		JA Project No.:	
Submittal Name:		Spec Section and/or DWG/Detail No.:	

Item No.	Description	Manufacturer / Vendor	Action Taken*

*The Action Designated Above is in Accordance with the Following Legend:
A – Accepted as Submitted
B – Approved as Noted
C – Revise and Resubmit
D – Incomplete – Resubmit
E – Submitted for Informational Purposes

Comments:

By:_____ Date:_____

O&M Manual Transmittal No. _____

Project Name:		Date to Engineer:	
Project Owner:		Reviewed By:	
Contractor:		JA Project No.:	
Submittal Name:		Spec Section and/or DWG/Detail No.:	

Item No.	Description	Manufacturer / Vendor	Action Taken*

*The Action Designated Above is in Accordance with the Following Legend:
A – Accepted as Submitted
B – Approved as Noted
C – Disapproved – Resubmit
D – Incomplete – Resubmit
E – Engineer's review not required

Comments:

By:_____ Date:_____

SECTION 01 40 00 – QUALITY REQUIREMENTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Quality control.

B. Tolerance.

C. References.

D. Labeling.

E. Mockup requirements.

F. Testing and inspection services.

G. Manufacturers' field services.

1.2 QUALITY CONTROL

A. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.

B. Comply with specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

C. Perform Work using persons qualified to produce required and specified quality.

D. Products, materials, and equipment may be subject to inspection by Engineer at place of manufacture or fabrication. Such inspections shall not prevent Contractor of complying with requirements of Contract Documents.

E. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do

not permit tolerance to accumulate.

B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current as of date of Contract Documents except where specific date is established by code.

C. Obtain copies of standards and maintain on Site when required by product Specification Sections.

D. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

E. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference in reference documents.

1.5 LABELING

A. Attach label from agency approved by authorities having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.

B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label:
   1. Model number.
   2. Serial number.
   3. Performance characteristics.

C. Manufacturer's Nameplates, Trademarks, Logos, and Other Identifying Marks on Products: Not allowed on surfaces exposed to view in public areas, interior or exterior.

1.6 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in individual

product Specification Sections.

B. Assemble and erect specified or indicated items with specified or indicated attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mockups shall be comparison standard for remaining Work.

D. Where mockup has been accepted by Engineer and is specified in product Specification Sections to be removed, remove mockup and clear area when directed to do so by Engineer.

1.7 TESTING AND INSPECTION SERVICES

A. The contractor will employ and pay for the specified services of an independent firm to perform testing and inspection.

B. An independent firm will perform tests, inspections, and other services specified in the project specifications and as required by Engineer, Owner and authorities having jurisdiction.

C. Testing, inspections, and source quality control may occur on or off Project Site. Perform off-Site testing as required by Engineer or Owner.

D. Reports shall be submitted by independent firm to Engineer, Contractor, and authorities having jurisdiction, in duplicate, indicating observations and results of tests and compliance or noncompliance with Contract Documents.
   1. Submit final report indicating correction of Work previously reported as noncompliant.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and independent firm 24 hours before expected time for operations requiring services.

F. Employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work according to requirements of Contract Documents.

G. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by same independent firm on instructions from Engineer.

H. Agency Responsibilities:
   1. Test Samples submitted by Contractor.
   2. Provide qualified personnel at Site. Cooperate with Engineer and Contractor in performance of services.
   3. Perform indicated inspections, sampling and testing according to specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of

Work or products.

6. Perform additional tests required by Engineer.
7. Attend preconstruction meetings and progress meetings.

I. Agency Reports: After each test, promptly submit copies of report to Engineer, Contractor, and authorities having jurisdiction. When requested by Engineer, provide interpretation of test results. Include the following:

1. Date issued.
2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and Specification Section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

J. Limits on Testing Authority:

1. Agency or laboratory may not release, revoke, alter, or amend requirements of Contract Documents.
2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

1.8 MANUFACTURER'S FIELD SERVICES

A. When specified in individual Specification Sections, require manufacturers to provide qualified personnel to inspect installation, provide equipment startup, testing, and adjustment services as applicable.

B. Refer to Section 01 33 00 - Submittal Procedures, "Manufacturer's Field Reports" Article.

END OF SECTION 01 40 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 – GENERAL

1.1 MOBILIZATION

A. Mobilization shall include, but not be limited to, these principal items:
   1. Obtaining required permits.
   2. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
   3. Arranging for and erection of the CONTRACTOR's work and storage yard.
   4. Posting OSHA required notices and establishing safety programs and procedures.
   5. Having CONTRACTOR's superintendent at site full time.

B. Area is available at the site for CONTRACTOR's temporary facilities as defined by the Limits of Construction shown on the Drawings.

1.2 PROTECTION OF WORK AND PROPERTY

A. Inform the OWNER and Engineer immediately of serious onsite accidents and related claims.

B. Use of Explosives: No blasting or use of explosives is allowed.

PART 3 – EXECUTION

3.1 TEMPORARY UTILITIES

A. Power:
   1. Electric power is available at the site.

B. Water:
   1. No potable water is available on site. Contractor shall bear costs of providing water required for construction purposes and for drinking by construction personnel during construction.

C. Sanitary and Personnel Facilities:
   1. Provide and maintain facilities for CONTRACTOR's employees, Subcontractors, and all other onsite personnel. Service, clean, and maintain facilities and enclosures.

D. Fire Protection: Furnish and maintain on site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).

3.2 PROTECTION OF WORK AND PROPERTY

A. Utilities:

1. Maintain in continuous service all existingoil and gas pipelines, underground or overhead power, telephone or communication cable, water mains, irrigation lines, sewers, polesand overhead power, and all other utilities encountered during completion of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
2. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
3. Locations of existing utilities shown on the Plans should be considered approximate. The Contractor shall verify the location of any potentially affected utility prior to starting work in any area.
4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
5. Always keep fire hydrants and water control valves free from obstruction and available for use.
6. In areas where CONTRACTOR's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by CONTRACTOR.
7. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance. Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to CONTRACTOR's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
8. Do not impair operation of existing water and sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
9. Utilities or appurtenances, driveways, drainage structures, roadways or other public or private improvements which are damaged by the Contractor shall be replaced to their original condition at no cost to the Owner.

B. Easements and Public Right-of-Way:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. No residence or business shall be cut off from vehicular traffic for a period exceeding 2 hours unless special arrangements have been made.
3. CONTRACTOR shall repair all damages to any existing utility line, fence, driveway, or other improvement that occurs because of the Work with such repairs to be made with materials of like quality and in a manner that restores the facility to its prior capacity, condition and function as soon as practical.

4. Where completion of the Work requires temporary or permanent removal or relocation of existing fencing, Contractor is responsible for providing temporary or permanent fencing equivalent to the existing or better to the satisfaction of the Engineer and property owner. Coordinate all activities with the Engineer and property owner prior to any relocation or removal.
5. The Contractor is responsible for assuring that adequate temporary fencing is provided to assure that livestock or personnel do not enter the construction area.
6. The contractor shall keep all existing gates closed except when in actual use.
7. If an existing fence is temporarily or permanently removed for construction or if an existing gate must remain open, CONTRACTOR shall provide temporary fencing or other arrangements approved by the Engineer to prevent movement of livestock between the areas the removed fence or open gate was designed to separate and shall promptly replace the removed fence with permanent fencing of substantially the same quality and material as the fence so removed.
8. CONTRACTOR shall remove all spoils from construction activities such as rocks, brush, and other debris from the site and shall properly dispose of all such material within 30 days. CONTRACTOR shall provide written approval by the landowner prior to placing any material removed from the site on private property.
9. The CONTRACTOR shall not engage in or allow any hunting, fishing, or trapping on the site or private property adjacent to the site.
10. Maintain original site drainage and restore original surface contours except where specifically indicated on the Plans or were approved by the Engineer.

C. Waterways:
1. Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.
2. Comply with all requirements of the Storm Water Pollution Prevention Plan (SWPPP) prepared for the project if applicable.

3.3 TEMPORARY CONTROLS

A. Air Pollution Control:
1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction areas a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

END OF SECTION 01 50 00

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Revegetation of disturbed areas.

E. Performance bond.

F. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing.

B. Section 31 2200 - Grading.

C. Section 31 2316 - Excavation.

D. Section 31 2323 - Fill.

1.03 REFERENCE STANDARDS

A. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus; 2014.

B. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2017.

C. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2011.

D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a.

E. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile; 2012.

F. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples; 2002 (Reapproved 2009).

G. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; Current Edition.

H. FHWA FLP-94-005 - Best Management Practices for Erosion and Sediment Control; 1995.

I. USDA TR-55 - Urban Hydrology for Small Watersheds; USDA Natural Resources Conservation Service; 2009.

J. Texas Commission on Environmental Quality - Storm Water Pollution Prevention Plan (SWPPP) requirements.

K. State, local, County and Municipal SWPPP requirements.

1.04 PERFORMANCE REQUIREMENTS

A. Comply with all requirements for erosion and sedimentation control, as specified for the Texas Pollutant Discharge Elimination System (TPDES), Phases I and II, under requirements for the Construction General Permit (CGP); current edition.

B. Comply with all more stringent requirements of the County and municipal.

C. Comply with all requirements of the SWPPP for erosion and sedimentation control.

D. Best Management Practices Standard: FHWA FLP-94-005.

E. Runoff Calculation Standard for Urban Areas: USDA TR-55.

F. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.

G. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
   1. Contractor will obtain permits and pay for securities required by authority having jurisdiction.
   2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.

H. If required by the Owner, provide a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.

I. Timing: Put preventive measures in place as soon as possible before disturbance of surface cover and before precipitation occurs.

J. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 10 years.

K. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

L. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud and sediment onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

M. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

N. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

O. Open Water: Prevent standing water that could become stagnant.

P. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mulch:
   1. Straw or hay.
   2. Wood waste, chips, or bark.
   3. Erosion control matting or netting.

B. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

C. Bales: Bound, rectangular straw bales.

D. Bale Stakes:
   1. Steel U- or T-section.
   2. Wood.
   3. Minimum Length: 3 feet.

E. Silt Fence Fabric: Polypropylene, polyethylene, or polyamide woven or nonwoven geotextile fabric resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
   1. Minimum Unit Weight: 4.5 oz/yd.
   2. Minimum Width: 36 inches.
   3. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
   4. Mullen Burst Strength: 190 lb/sq in.
   5. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491/D4491M.
   6. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.

7. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
8. Tear Strength: 55 pounds-force, minimum, when tested in accordance with ASTM D4533.
9. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
10. Woven Wire Backing: 2"x4" 12 gauge (min.), welded wire, galvanized.

F. Silt Fence Posts:
1. Steel Y- or T-section, with minimum mass of 1.25 lb per linear foot.
2. Minimum Length: 4 feet.
3. Galvanized or painted surface.
4. Brindle Hardness: Greater than 140.

G. Riprap: See Section 31 3700.

H. Filter Bags: Polypropylene, polyethylene or polyamide woven fabric.
1. Unit Weight: 4 oz/sq yd.
2. Mullen Burst Strength: Greater than 300 psi.
3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D 4355 after 500 hours exposure.
4. Filter Bag Fill: Washed pea gravel to coarse ground (0.31" to 0.75" diameter).

I. Rock Berms
1. Rock: Clean, open graded, 3 to 5 inch diameter; high velocity areas should use 5 to 8 inch diameter.
2. Woven wire; 20 gauge, maximum 1" opening, galvanized, secured with shoat rings.

J. Stabilized Construction Entrance
1. Rock: 4" to 8", washed.
2. Fabric: Geotextile specific for soil filtration; 6 oz/sq yd; Mullen burst rating of 140 lb/sq in, greater than #50 sieve opening size.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances: Traffic-bearing aggregate surface.
1. Width: 12 feet, minimum, or full width of driveway, whichever is greater.
2. Length: 50 feet, minimum.
3. Provide at each construction entrance from public right-of-way.
4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences or rock riprap.
1. Provide linear sediment barriers as detailed on drawings with the following parameters:

a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
b. Along the top of the slope or top bank of drainage channels and swales that traverse disturbed areas.
c. Along the toe of cut slopes and fill slopes.
d. Perpendicular to flow across the bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space at maximum of 200 feet apart.
e. Across the entrances to culverts that receive runoff from disturbed areas.

D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
1. Bagged gravel inlet protection: As detailed on drawings.

E. Storm Drain Inlet: As detailed on drawings.

F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

G. Soil Stockpiles: Protect using one of the following measures:
1. Cover with polyethylene film, secured by placing soil on outer edges.
2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 4 inches of straw or hay.

H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.

I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

A. Traffic-Bearing Aggregate Surface:
1. Excavate minimum of 3 inches.
2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
3. Place and compact at least 6 inches of 1 1/2 to 3 1/2 inch diameter stone.
4. Reference details on the drawings.

B. Silt Fences:
1. Install with top of fabric at nominal height and embedment indicated on drawings.
2. Embed bottom of fabric in a trench on the upslope side of fence, with 6 inches of fabric laid flat on bottom of trench facing upslope; backfill trench and compact.
3. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
4. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
5. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.
6. Reference details on the drawings.

C. Straw Bale Rows:
1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
2. Install bales so that bindings are not in contact with the ground.
3. Embed bales at least 4 inches in the ground.

4. Anchor bales with at least two stakes per bale, driven at least 18 inches into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
5. Fill gaps between ends of bales with loose straw wedged tightly.
6. Place soil excavated for trench against bales on the upslope side of the row, compacted.

D. Mulching Over Large Areas:
1. Dry Straw and Hay: Apply 2-1/2 tons per acre; anchor using dull disc harrow or emulsified asphalt applied using same spraying machine at 100 gallons of water per ton of mulch.
2. Wood Waste: Apply 6 to 9 tons per acre.
3. Erosion Control Matting: Comply with manufacturer's instructions.

E. Mulching Over Small and Medium Areas:
1. Dry Straw and Hay: Apply 4 to 6 inches depth.
2. Wood Waste: Apply 2 to 3inches depth.
3. Pine Needles: Apply 2 to 3 inches depth.
4. Erosion Control Matting: Comply with manufacturer's instructions.

F. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
5. Incorporate fertilizer into soil before seeding.
6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
8. Repeat irrigation as required until grass is established.

G. Rock Berms
1. Layout the woven wire mesh sheathing perpendicular to the direction of runoff.
2. Rock berm will have a minimum top width of 2 feet with side slopes being 2:1 (h:v) or flatter.
3. Place rock along the sheathing to a height not less than 18".
4. Wrap the wire sheathing around the rock and secure with tie wire so that the ends of the sheathing overlap a minimum of 2 inches.
5. Tie the ends of the berm into the existing upslope grade and bury the berm 3 to 4 inches into existing ground slope.

H. Stabilized Construction Entrance
1. Remove vegetation and grade for positive drainage.
2. Construct entrance a minimum 12 feet wide (or full width of road) by 50 feet long.
3. If slope towards a paved street exceeds 2 percent, construct a ridge 6 to 8 inches high with 3:1 (h:v) side slopes across the foundation 15 feet from the entrance to divert runoff away from street.

4. Place geotextile woven fabric in graded foundation.
5. Place stone over geotextile woven fabric per the drawings.
6. Grade to drain runoff to a sediment trap or basin.
7. Install drain pipe, as needed, to maintain street drainage in right-of-way.

3.05 MAINTENANCE

A. Inspect preventive measures daily, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Silt Fences:
   1. Promptly replace fabric that deteriorates.
   2. Remove silt deposits that exceed one-third of the height of the fence.
   3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

D. Straw Bale Rows:
   1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
   2. Remove silt deposits that exceed one-half of the height of the bales.
   3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

E. Filter Bags:
   1. Promptly replace bags that have deteriorated or have been damaged.
   2. Remove silt deposits that exceed one-third the height of the bag.
   3. Repair or replace bags that are undercut by runoff or otherwise are damaged, whether by runoff or other causes.

F. Stabilized Construction Entrance
   1. Promptly replace rock that has deteriorated or been damaged.
   2. Remove excess dirt and sediment accumulations as needed.

G. Rock Berms
   1. Promptly repair or replace rock berms that have been undercut by runoff or otherwise damaged.
   2. Remove silt deposits that exceed one-third the height of the rock berm.
   3. Repair any loose wire sheathing.

H. Clean out temporary sediment control structures weekly and relocate soil on site.

I. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product delivery requirements.

C. Product storage and handling requirements.

D. Product options.

E. Equipment electrical characteristics and components.

1.2 PRODUCTS

A. At minimum, comply with specified requirements and reference standards.

B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.

C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that manufacturer's production schedule can meet Project requirements. Advise Engineer of any production schedules that cannot meet project schedule.

D. Do not use materials and equipment removed from existing premises except as specifically permitted by Contract Documents.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products according to manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products; use methods to prevent damage.

D. Contractor is responsible to provide security measures to prevent theft or vandalism.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products according to manufacturer's instructions.

B. Store products with seals and labels intact and legible.

C. Store sensitive products in weathertight, climate-controlled enclosures or suitable environment.

D. Provide bonded off-Site storage and protection when Site does not permit on-Site storage or protection.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

G. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable conditions.

END OF SECTION 01 60 00

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Field engineering.

B. Closeout procedures.

C. Starting of systems.

D. Demonstration and instructions.

E. Testing, adjusting, and balancing.

F. Project record documents.

G. Operation and maintenance data.

H. Manual for materials and finishes.

I. Manual for equipment and systems.

J. Spare parts and maintenance products.

K. Product warranties and product bonds.

L. Maintenance service.

M. Examination.

N. Preparation.

O. Execution.

P. Cutting and patching.

Q. Protecting installed construction.

R. Final cleaning.

1.2 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:
   1. Submit Operation and Maintenance Manuals, Project record documents, and other similar final record data in compliance with this Section.
   2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
   3. Conduct inspection to confirm that Work is substantially complete. Create a comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
   4. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
   5. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
   6. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:
   1. When Contractor considers Work to be substantially complete, submit to Engineer:
      a. Written certificate that Work, or designated portion, is substantially complete.
      b. List of items to be completed or corrected (initial punch list).
   2. Within seven days after receipt of request for Substantial Completion, Engineer will make inspection to determine whether Work or designated portion is substantially complete.
   3. Should Engineer determine that Work is not substantially complete:
      a. Engineer will promptly notify Contractor in writing, stating reasons for its opinion.
      b. The contractor shall remedy deficiencies in the Work and send a second written request for Substantial Completion to the Engineer.
      c. Engineer will reinspect Work.
   4. When Engineer finds that Work is substantially complete, Engineer will:
      a. Prepare Certificate of Substantial Completion on 00 65 16 - Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
      b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.
   5. After Work is substantially complete, Contractor shall:
      a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
      b. Complete Work listed for completion or correction within the time stipulated.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.
   1. When Contractor considers Work to be complete, submit written certification that:
      a. Contract Documents have been reviewed.

b. Work has been examined for compliance with Contract Documents.
c. Work has been completed according to Contract Documents.
d. Work is completed and ready for final inspection.

2. Submittals: Submit following:
   a. Final punch list indicating all items have been completed or corrected.
   b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
   c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
   d. Accounting statement for final changes to Contract Sum.
   e. Contractor's affidavit of payment of debts and claims on AIA G706 - Contractor's Affidavit of Payment of Debts and Claims.
   f. Contractor affidavit of release of liens on AIA G706A - Contractor's Affidavit of Release of Liens.
   g. Consent of surety to final payment on AIA G707 - Consent of Surety to Final Payment Form.
3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:
1. Within seven (7) days after receipt of request for final inspection, Engineer will make inspection to determine whether Work or designated portion is complete.
2. Should Engineer consider Work to be incomplete or defective:
   a. Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.
   b. Contractor shall remedy stated deficiencies and send second written request to Engineer that Work is complete.
   c. Engineer will re-inspect Work.

1.3 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify Engineer seven (7) days prior to startup of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.

G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.

H. Submit a written report according to Section 01 33 00 - Submittal Procedures to ensure that equipment or system has been properly installed and is functioning correctly.

1.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of final inspection.

B. Demonstrate Project equipment and instructed by authorized manufacturer's representative who is knowledgeable about the Project.

C. For equipment or systems requiring seasonal operation, perform demonstrations for other season within six months.

D. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. Required instruction time for each item of equipment and system is specified in individual Specification Sections.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain on Site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed Shop Drawings, product data, and Samples.
   6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:
   1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
   2. Include locations of concealed elements of the Work.
   3. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
   4. Identify and locate existing buried or concealed items encountered during Project.
   5. Field changes of dimension and detail.
   6. Details not on original Drawings.

F. Submit PDF electronic files of marked-up documents to Engineer with claim for final Application for Payment.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit in PDF composite electronic indexed file.

B. Submit data bound in 8-1/2 x 11-inch text pages, three D side ring binders with durable plastic covers.

C. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," title of Project, and subject matter of binder when multiple binders are required.

D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

F. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
   1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
   2. Part 2: Operation and maintenance instructions, arranged by system and subdivided alphabetically. For each category, identify names, addresses, and telephone numbers of

Subcontractors and suppliers. Include the following:

a. Significant design criteria.
b. List of equipment.
c. Parts list for each component.
d. Operating instructions.
e. Maintenance instructions for equipment and systems.
f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
g. Safety precautions to be taken when operating and maintaining or working near equipment.

3. Part 3: Project documents and certificates, including the following:
   a. Shop Drawings and product data.
   b. Certificates.
   c. Originals of warranties.

1.7 MANUALS FOR OPERATION AND MAINTENANCE

A. Submit a copy of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return a copy with comments.

B. Submit a bookmarked PDF copy and one printed copy of revised final volumes within ten days after final inspection.

C. Additional Requirements: As specified in individual product Specification Sections.

D. Include table of contents for design data, with tabbed fly sheet and space for insertion ofdata.

1.8 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit a copy of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return a copy with comments.

B. Submit a bookmarked PDF copy and one printed copy of revised final volumes within ten days after final inspection.

C. Additional Requirements: As specified in individual product Specification Sections.

D. Include table of contents for design data, with tabbed fly sheet and space for insertion ofdata.

E. Each Item of Equipment and Each System: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model

number of replaceable parts.

F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; by label machine.

G. Include color-coded wiring diagrams as installed.

H. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.

I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

J. Include servicing and lubrication schedule and list of lubricants required.

K. Include manufacturer's printed operation and maintenance instructions.

L. Include sequence of operation by controls manufacturer.

M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

N. Include control diagrams by controls manufacturer as installed.

O. Include Contractor's coordination drawings with color-coded piping diagrams as installed.

P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

R. Include test and balancing reports as specified in Section 01 40 00 - Quality Requirements.

S. Include warranty information for all equipment installed.

T. Additional Requirements: As specified in individual product Specification Sections.

1.2 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual

Specification Sections.

B. Deliver to Project Site and place in location as directed by Owner; obtain receipt prior to final payment.

END OF SECTION 01 70 00

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. CONTRACTOR shall maintain and provide the OWNER with project record documents as specified below.

B. Maintenance of Documents
   1. Maintain in CONTRACTOR's field office in clean, dry, legible condition complete sets of the following: Contract Drawings, Specifications, Addenda, approved Shop Drawings, Samples, Change Orders, other Modifications of Contract, Test Records, Survey Data, Field Orders, and all other documents pertinent to CONTRACTOR's Work.
   2. Always make documents available for inspection by the OWNER.
   3. Record documents shall not be used for any other purpose and shall not be removed from the office without the OWNER’s approval.

C. Recording
   1. Label each document "PROJECT RECORD".
   2. Keep record documents current and updated at least weekly.
   3. Do not permanently cover any Work until required information has been recorded.
   4. Contract Drawings - Legibly mark to record actual construction including:
      a. Depths of various elements of manhole foundation in relation to datum.
      b. The horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
      c. Field changes of dimensions and details.
      d. Changes made by Change Order or Field Order.
      e. Details not on original Contract Drawings.
      f. Changes of different methods of construction.
      g. Use of different products not specified.
   5. Specifications and Addenda - Legibly mark up each Section to record:
      a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment installed.
      b. Changes made by Change Order or Field Order.
      c. Other matters not originally specified.
   6. Shop Drawings - Maintain as record documents and legibly annotate drawings to record changes made after review.
   7. Record Documents will be reviewed by the OWNER and the CONTRACTOR monthly and failure to keep documents accurate and current will be the basis for the OWNER to withhold the CONTRACTOR's monthly payment in partial or full.

D. Record Drawings

   1. Record drawings shall reflect completion of the installation of all equipment, piping, and other work by the CONTRACTOR. The drawings shall show the Work in plan and sections as required for clarity with reference dimensions and elevations for complete

record. The drawings shall be furnished not later than 30 days after completion of the Work and prior to final payment.

2. The Contract Drawings may be used as a starting point in developing these drawings. Subcontractor and manufacturer drawings may be included in this drawing package. The drawing package must be fully integrated and include the necessary cross references between drawings. The drawing package shall include interconnection, numbering, and termination details to equipment furnished under this Contract.

E. Submittal

1. At project completion, deliver recorded documents to the OWNER. Place all letter-sized material in a three (3) ring binder, which is neatly indexed by process and division number. Bind Contract drawings and shop drawings in rolls of convenient size for ease of handling.
2. Accompany the submittal with a transmittal letter in duplicate containing the following:
   a. Date.
   b. Project title and number.
   c. CONTRACTOR's name and address.
   d. Title and number of each recorded document.
   e. Certification that each document as submitted is complete and accurate.
   f. Signature of CONTRACTOR.

END OF SECTION 01 78 39

SECTION 03 10 00 - CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

This section describes the design, construction and installation of concrete formwork.

1.2 REFERENCES

A. Referenced Standards:

1. American Concrete Institute (ACI)

a. 318/318R: Building Code Requirements for Structural Concrete and Commentary.

b. 347: Guide to Formwork for Concrete.

2. Engineered Wood Association (APA)

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions and Section 01340.

B. Submit manufacturer's literature for form ties, spreaders, corner formers, form coatings, and bond breakers.

PART 2 - PRODUCTS

2.1 FORM CONSTRUCTION AND DESIGN

A. Design forms according to the applicable portions of ACI 347. Form all concrete, except as specified otherwise.

B. Provide form windows or stage forms to allow visual observation at all times of the concrete being placed and vibrated. Provide a formwork design and placement schedule that will limit free fall of concrete in walls 8 inches or less in thickness to 4 feet and for walls thicker than 8 inches, limit this fall to 6 feet. Total vertical lift made in a single pass shall not exceed 2 feet in height.

C. Notify the Owner's Representative prior to concrete placement (48 hours minimum).

D. Steel forms shall be minimum 16 gauge, with tongue-and-groove joints, complete with steel stakes and splice plates.

2.2 CLASSES OF FORMS

A. Class I Forms: Use steel forms, ply form, or smooth-surface plywood 3/4-inch minimum thickness for straight surfaces and 1/2-inch minimum thickness for curved surfaces.

B. Class II Forms: Use plywood in good condition, metal, or smooth-planed boards free from large or loose knots with tongue-and-groove or ship-lap joints.

C. Class II forms may be used for exterior concrete surfaces that are 1 foot or more below finished grade. Use Class I forms for all other surfaces.

2.3 FORM MATERIAL

A. Use plywood, lumber, and steel of sufficient strength and surface smoothness to produce the specified finish.

B. Lumber used in form construction shall be Douglas fir, No. 2 grade, S4S, Standard Grading and Dressing Rules No. 16, West Coast Lumber Inspection Bureau. Boards shall be 6 inches or more in width.

C. Plywood used in form construction shall be Grade B-B, Class 1 plyform, mill-oiled, and sanded on both sides in conformance with U.S. Product Standard PS-1.

2.4 FORM TIES

A. Locate form ties on exposed surfaces in a uniform pattern. Place form ties so they remain embedded in the concrete except for a removable portion at each end and do not leave an open hole through the concrete. Form ties shall have conical or spherical type inserts with a maximum diameter of 1 inch. Construct form ties so that no metal is within 1 inch of the concrete surface when the forms, inserts, and tie ends are removed. Do not use wire ties. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.

B. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1 inch and sufficient dimensions to permit patching of the tie hole.

C. Tapered form ties shall be tapered through-bolts at least 1 inch in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size.

2.5 BOND BREAKER

A. Bond breaker shall be a V.O.C.-compliant nonstaining type that will provide a positive bond prevention, such as Clean Lift 90 W.B. as manufactured by Edoco Burke; Silcoseal 97EC as manufactured by Nox-Crete, Inc.; or equal.

2.6 FORM RELEASE AGENT

A. Form release agent shall effectively prevent absorption of moisture by the form and prevent bond with the concrete. Agent shall be nonstaining, V.O.C.-compliant, leave concrete with a coatable surface, and be nontoxic after 30 days.

B. For steel forms, release agent shall prevent discoloration of the concrete due to rust.

PART 3 - EXECUTION

3.1 FORM TOLERANCES

A. The following table indicates tolerances or allowable variations from dimensions or positions of structural concrete work:

	Maximum Tolerance (inch)
Sleeves and inserts	+1/4 –1/4
Projected ends of anchors	+1/4 –0.0
Anchor bolt setting	+1/4 –1/4
Finished concrete, all locations	+1/4 -1/4 in 10 feet
	Max ±1-inch in total length

B. The planes or axes from which the above tolerances are to be measured shall be as follows:

Sleeves and inserts:	Centerline of sleeve or insert.
Projected end of anchors:	Plane perpendicular to the end of the anchor as located in the drawings.
Anchor bolt setting:	Centerline of anchor bolt.
Finish concrete:	The concrete surface as defined in the drawings.

C. Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.

D. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.

3.2 FORM SURFACE PREPARATION

A. Clean form surfaces to be in contact with concrete of foreign material prior to installation. Tape, gasket, plug, and/or caulk joints, gaps, and apertures in forms so that the joint will remain watertight and withstand placing pressures without bulging outward or creating surface irregularities.

B. Coat form surfaces in contact with concrete with a form release agent prior to form installation.

C. Keep form coatings off steel reinforcement, items to be embedded, and the previously placed concrete.

3.3 BEVELED EDGES (CHAMFER)

A. Form 3/4-inch beveled edges on exposed concrete edges and corners, beam soffit corners, and where indicated in the drawings. Reentrant corners in concrete members shall not have fillets, unless otherwise shown in the drawings. The top edges of slabs, walkways, beams, and walls may be beveled with an edging trowel in lieu of using chamfer strips.

3.4 FORM PLACEMENT

A. Provide means for holding adjacent edges and ends of form panels tight and in accurate alignment to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight and shall prevent the loss of mortar and fines during placing and vibration of concrete.

B. Provide one cleanout and inspection opening (12 inches wide by 18 inches high) every 7 feet at the bottom of each lift of forms.

C. Provide exterior corners in concrete members with bevels as specified.

D. Provide means for removing forms without injury to the surface of finished concrete.

E. Do not embed any form-tying device or part thereof other than metal in the concrete.

F. Locate large end of taper tie on the "wet" side of the wall.

G. Use only form or form-tying methods that do not cause spalling of the concrete upon form stripping or tie removal.

H. Form surfaces of concrete members except where placement of the concrete against the ground is shown in the drawings or as indicated below. The dimensions of concrete members shown in the drawings apply to formed surfaces, except where otherwise indicated. Add 2 inches of concrete where concrete is placed against trimmed undisturbed ground in lieu of forms. Placement of concrete against the ground shall be limited to footings and other nonexposed concrete and only where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing.

3.5 FORM REUSE

A. Reuse only forms that provide a uniform surface texture on exposed concrete surfaces. Apply light sanding or other surface treatment between uses for uniform texture. Plug unused tie rod holes with corks, shave flush, and sand the concrete surface side. Do not patch forms other than filling tie rod holes, except in the case of Class II forms. Do not use metal patching discs on Class I forms.

3.6 REMOVAL OF FORMS

A. Forms and shoring for elevated structural slabs or beams shall remain in place until the concrete has reached a compressive strength equal to the specified 28-day compressive strength as determined by test cylinders. Do not remove supports and reshore. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed:

Sides of footings and encasements	24 hours
Walls, vertical sides of beams, girders, columns, and similar members not supporting loads	48 hours
Slabs, beams, and girders	10 days (forms only)
Shoring for slabs, beams, and girders	Until concrete strength reaches specified 28-day strength
Wall bracing	Until top or roof slab concrete reaches specified 28-day strength

B. Do not remove forms from concrete that has been placed with outside air temperature below 50°F without first determining if the concrete has properly set without regard for time. Do not apply heavy loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.

3.7 FORMED OPENINGS

A. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.

3.8 EMBEDDED ITEMS

A. Set anchor bolts and other embedded items accurately before placing concrete and hold securely in position until the concrete is placed and set. Check special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after placing concrete. Check nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to placing concrete.

3.9 PIPES AND WALL SPOOLS CAST IN CONCRETE

A. Install wall spools, wall flanges, and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall spools or anchors to the reinforcing steel.

B. Support pipe and fabricated fittings to be encased in concrete-on-concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement will occur during construction.

C. Pipes or spools located below operating water level shall have water stop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 SUMMARY

A. This section describes materials, mixing, testing, and placing of concrete and grout.

1.2 REFERENCES

A. Unless otherwise indicated, materials, workmanship, and practices shall conform to the following standards:

1. 2021 Internation Building Code (IBC).

2. American Concrete Institute (ACI):

a. 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

b. 214R: Recommended Practice for Evaluation of Strength Test Results of Concrete

c. 301: Standard Specifications for Structural Concrete

d. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete

e. 304.2R: Placing Concrete by Pumping Methods

f. 305R: Hot Weather Concreting

g. 306R: Cold Weather Concreting

h. 308: Standard Practice for Curing Concrete

i. 309R: Guide for Consolidation of Concrete

j. 311.4R: Guide for Concrete Inspection

k. 318: Building Code Requirements for Structural Concrete

l. 350: Code Requirements For Environmental Engineering Concrete Structures

2. American Society for Testing and Materials International (ASTM):

a. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field

b. C33: Standard Specification for Concrete Aggregates

c. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete

Specimens

d. C40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete

e. C94: Standard Specification for Ready-Mixed Concrete

f. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or [50-mm] Cube Specimens)

g. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

h. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

i. C143: Standard Test Method for Slump of Hydraulic Cement Concrete

j. C150: Standard Specification for Portland Cement

k. C157: Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete

l. C171: Standard Specification for Sheet Materials for Curing Concrete

m. C172: Standard Practice for Sampling Freshly Mixed Concrete

n. C192:Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

o. C260: Standard Specification for Air-Entraining Admixtures for Concrete

p. C289: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)

q. C309:Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

r. C311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete

s. C494: Standard Specification for Chemical Admixtures for Concrete

t. C1240: Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout

u. D75: Standard Practice for Sampling Aggregates

v. E1745: Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

w. E329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

B. Where provisions of pertinent codes and standards conflict with this specification, the more stringent provisions govern.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions and Section 01 33 00.

B. Prepare concrete and mortar mix designs, laboratory 7-day and 28-day compressive strength tests, or submit test reports of 7- and 28-day compressive strength tests of the mix used on two previous projects. Prepare mix designs in accordance with ACI 318, Chapters 4 and 5, except as modified herein. Submit mix design in writing for review by the Owner at least 15 days prior to the placement of any concrete.

C. Provide certificate that cement used complies with ASTM C150 and these specifications.

D. Provide certificates that aggregates comply with ASTM C33 and contain less than 1% asbestos by weight or volume. State weathering region limits of coarse aggregates: severe, moderate, or negligible. State basis of determining that potential reactivity is negligible. Identify certifications and tests to actual materials to be used in the work. Provide additional tests and certifications for each change in material source. Provide an alternate material source of aggregate if tests indicate that aggregates are reactive or possess severe weathering potential. Submit gradation analysis with concrete mix designs.

E. Provide delivery tickets for ready-mix concrete or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate.

F. Provide certificate of compliance with these specifications from the manufacturer of the concrete admixtures.

G. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's certifications as to suitability of product to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.

H. Provide non-shrink grout manufacturer's product data and specific instructions for use.

I. Plant Qualification: Submit certification from the National Ready Mixed Concrete Association indicating compliance with the specified qualification requirements.

1.4 QUALIFICATION ASSURANCE

A. Meet requirements of the Check List for Certification of Ready Mixed Concrete Production facilities of the National Ready Mixed Concrete Association and ASTM C94.

1.5 QUALITY ASSURANCE

A. Reinforced concrete shall comply with ACI 301, ACI 318, the recommendations of ACI 350R and other stated requirements herein.

B. Tests for compressive strength and slump of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

C. The cost of all tests will be borne by the Contractor. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications.

D. Concrete for testing shall be supplied by the Contractor at no cost to the Owner, and the Contractor shall provide assistance to the Engineer or testing laboratory personnel in obtaining samples. The Contractor shall dispose of and clean up all excess material. Reference the "Field Control Testing" section of this specification.

E. Construction Tolerances: The Contractor shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

F. Casting of cylinders: Field testing shall be performed by a person on-site who is certified as an ACI Concrete Field Testing Technician, Grade 1 or equivalent.

PART 2 – PRODUCTS

2.1 NON-DOMESTIC CEMENT AND ADDITIVES

A. The use of nondomestic cement and additives in concrete may be permitted only after review of a written request to use such materials. The request to use nondomestic materials shall include a chemical analysis that indicates the material meets the project specifications. Certifications that state the nondomestic materials meet the project requirements will not be accepted.

B. Test reports for concrete materials shall be current to within three months of inclusion into the project and shall be identifiable to the materials supplied.

2.2 CEMENT

A. Unless cement not made within the United States has been approved, use domestic portland cement that conforms to ASTM C150, Type II.

B. Use only one brand of cement in any individual structure. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.

C. Maximum tricalcium aluminate shall not exceed 8%. The maximum percent alkalies shall not exceed 0.6%.

2.3 AGGREGATES

A. Aggregates shall be natural rock, sand, or crushed natural rock and shall comply with ASTM C33, and shall contain less than 1% asbestos by weight or volume. Aggregates shall be free from any substances that will react with the cement alkalies, as determined by Appendix X-1 of ASTM C33.

2.4 WATER AND ICE

A. Use water and ice that is clean and free from objectionable quantities of organic matter, alkali, salts, and other impurities that might reduce the strength, durability, or otherwise adversely affect the quality of the concrete. Water shall not contain more than 500 mg/L of chlorides or more than 500 mg/L of sulfate.

2.5 COLOR ADDITIVE FOR EXTERIOR ELECTRICAL DUCT ENCASEMENT

A. For exterior electrical duct concrete encasements, use a color additive for identification purposes: brick red "Colorfull" as manufactured by Owl Manufacturing Company, Arcadia, California; coral red "Chromix C-22" as manufactured by L. M. Scofield Company, Los Angeles, California; or equal. Add the color additive while the concrete is being mixed using the quantity per cubic yard of concrete recommended by the manufacturer for the class of concrete indicated.

2.6 CONCRETE ADMIXTURES

A. Class A concrete shall contain an air-entraining admixture conforming to ASTM C260. Admixtures shall be Master Builders MB-AE 90, Sika AER, or equal.

B. Class A concrete shall contain a water-reducing admixture conforming to ASTM C494, Type A. It shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations. Admixtures shall be Master Builders Pozzolith polymer-type normal setting, Plastocrete 161 or Plastiment, Sika Chemical Corporation, or equal.

C. Mineral Admixture: Class A concrete shall contain a mineral admixture, fly ash Class F, conforming to ASTM C618, not to exceed or replace more than 15% of the cement material required without the mineral admixture.

D. Do not use any admixture that contains chlorides or other corrosive elements in any concrete. Admixtures shall be nontoxic after 30 days.

E. Class A concrete for water bearing structures shall contain Xypex concrete waterproofing by Crystallization admixture.

2.7 SUPERPLASTICIZER

A. Comply with ASTM C1017, Type 1 or 2.

2.8 NON-SHRINK GROUT

A. Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-621-83, and to these specifications. Use a nongas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be Sikagrout 928, Master Flow 713, or equal. Components shall be inorganic.

2.9 ORDINARY TYPE GROUT (DRY PACK)

A. One part portland cement to two parts sand (100% passing a No. 8 sieve). Add sufficient water to form a damp formable consistency.

2.10 EPOXY GROUT

A. Mix the two components of epoxy bonding compound in compliance with the manufacturer's instructions.

B. Use sand that is oven dry and meets the following gradation requirements for epoxy grout.

Sieve Size	**No. 8**	**No. 50**	**No. 100**
% Passing	100	30 ±15	5 ±5

C. Epoxy primer shall be a lead free, chrome free, rust inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout products. Products: Escoweld 1014E Rust Inhibitive Epoxy Primer or equal.

D. Nonbonding Filler for Anchor Bolt Sleeves: Escoweld 7506 or equal.

E. Epoxy Grout Liquid: Escoweld 7502E or 7507E or equal.

2.11 JOINT MORTAR BED

A. Mortar or grout placed on horizontal construction joints shall be a mixture of cement, sand, and water in the same proportions used in the concrete but with coarse aggregate omitted.

2.12 EPOXY BONDING COMPOUND

A. Bonding compound shall be Sikadur 32 Hi-Mod, Sika Chemical Corporation, Lyndhurst, New Jersey; Concresive by BASF; Euco Epoxy 452 by Euclid Chemical Company; or equal.

2.13 NON-EPOXY BONDING COMPOUND

A. Use Weldcrete by Larsen Products Corp., Link by Sta-Dry Manufacturing Corp., Euco Weld by Euclid Chemical Co., or equivalent. The compound shall be rewettable for up to two weeks.

2.14 CONCRETE MIX DESIGN

A. Conform to ASTM C94, except as modified by these specifications.

B. Air content as determined by ASTM C231 shall be 4% ±1%.

C. Maximum water-cement ratio for Class A concrete = 0.45 by weight.

D. Provide concrete as indicated on the drawings or with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318, "Proportioning on the Basis of Field Experience," to achieve 28-day compressive strength as follows:

Class	**Type of Work**	**28-Day Minimum Compressive Strength (in psi)**	**Minimum Cement Content (in lbs per C.Y.)**
A	Concrete for all structures and concrete not otherwise specified. Concrete fill at structure foundations, cradle, supports across pipe trenches, and reinforced pipe encasement.	4,000	564
C	Concrete topping, miscellaneous unreinforced concrete.	2,000	376
E	Concrete as specified	5,000	630

E. Measure slump in accordance with ASTM C143. Slump shall be as follows:

1. Slab on grade or heavy sections wider (in plan view) than 3 feet: 3 inches maximum.

2. Footings, walls, suspended slabs, beams, and columns: 4 inches maximum.

F. Aggregate size shall be 3/4 inch maximum for slabs and sections 8 inches thick and less. Aggregate size shall be 1 inch maximum for sections greater than 8 inches and less than 17 inches. Aggregate size shall be 1 1/2 inches maximum for all larger slabs and sections. Aggregate size for floor grout shall be maximum 3/8 inch.

G. Combined aggregate grading shall be as shown in the following table:

	Maximum Aggregate Size			
	1 1/2"	**1"**	**3/4"**	**3/8"**
Aggregate Grade per ASTM C33	467	57	67	8

H. Mix design for pumped concrete shall produce a plastic and workable mix. The percentage of sand in the mix shall be based on the void content of the coarse aggregate.

2.15 GRANULAR BASE

A. Use structural backfill material as specified in Section 02 22 20.

2.16 WORKABILITY

A. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the materials to segregate or free water to collect on the surface.

B. Adjust the proportions to secure a plastic, cohesive mixture, and one that is within the specified slump range.

C. To avoid unnecessary changes in consistency, obtain the aggregate from a source with uniform quality, moisture content, and grading. Handle materials to minimize variations in moisture content that would interfere with production of concrete of the established degree of uniformity and slump.

PART 3 – EXECUTION

3.1 READY-MIXED CONCRETE

A. Provide ready-mixed concrete conforming to ASTM C94 as modified by these specifications.

B. Convey concrete from the truck to the place of final deposit as rapidly as practicable by methods that will prevent segregation or loss of ingredients to maintain the quality of the concrete. Place no concrete more than 90 minutes after mixing has begun for that particular batch. If it is necessary to add water to obtain the specified slump, add water per ASTM C94, but do not exceed the water content of the reviewed design mix.

C. Use dry-batched concrete or jobsite mix only when haul time is excessive. Do not retemper partially hardened concrete.

D. Keep a record showing time and place of each pour of concrete, together with transit-mix delivery slips certifying the contents of the pour.

3.2 PRIOR TO PLACING CONCRETE

A. Subgrade: Compact the subgrade and/or bedding. Saturate the subgrade approximately eight hours before placement and sprinkle ahead of the placement of concrete in areas where vapor barrier is not used. Remove all standing water, mud, and foreign matter before concrete is deposited.

B. Granular Base: When indicated in the drawings, install a granular base beneath the slab on grade or a structural foundation. Place the granular material on a compacted subgrade and compact the granular base to the same density as the subgrade.

3.3 PLACING CONCRETE

A. Placement shall conform to ACI 304 as modified by these specifications.

B. Coordinate in advance of concrete placement the sequence of placement to assure that

construction joints will occur only as designed. Provide Owner's Representative with a copy of the sequence of placement in advance of placement.

C. Alternate sections of concrete walls and slabs may be cast simultaneously. Do not place adjacent sections of walls and slabs until seven days after placement of first placed concrete.

D. Notify the Owner's Representative of readiness, not just intention, to place concrete in any portion of the work. This notification shall be such time in advance of the operation as the Owner's Representative deems necessary to allow observation of the work at the location of the proposed concrete placing. Failure of sufficient advance notification will be cause for delay in placing until observations can be completed. Forms, steel, screeds, anchors, ties, inserts, and other embedded items shall be in place before the Contractor's notification of readiness is given.

E. Schedule sufficient equipment for continuous concrete placing. Provide for backup equipment and procedures to be taken in case of an interruption in placing. Provide backup concrete vibrators at the project site. Test concrete vibrators the day before placing concrete.

F. Do not place concrete until all free water has been removed or has been diverted by pipes or other means and carried out of the forms, clear of the work. Do not deposit concrete underwater, and do not allow free water to rise on any concrete until the concrete has attained its initial set. Do not permit free or storm water to flow over surfaces of concrete so as to injure the quality or surface finish.

G. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing. Do not deposit concrete in large quantities in one place to be worked along the forms with a vibrator.

H. Use mechanical vibration in placing concrete to eliminate rock pockets and voids, to consolidate each layer with that previously placed, to completely embed reinforcing bars and fixtures, and to bring just enough fine material to exposed surfaces to produce a smooth, dense, and even texture. Vibrators shall be of the high-frequency internal type, and the number in use shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least two vibrators shall be available at the site. Use external vibrators for consolidating concrete when the concrete is otherwise inaccessible for adequate consolidating. Construct forms with sufficient strength to resist displacement or damage when external vibrators are used.

I. Do not place concrete during rainstorms. Protect concrete placed immediately before rainstorms to prevent rainwater from coming in contact with freshly placed or uncured concrete. Keep sufficient protective covering ready at all times for this purpose.

J. Elephant Trunks: Use hoppers and elephant trunks or drop chutes to prevent the free fall of concrete that results in separation of coarse particles.

K. Chutes: Use metal or metal-lined chutes with a slope not exceeding one vertical to two

horizontal and not less than one vertical to three horizontal. Chutes more than 20 feet long and chutes not meeting the slope requirement may be used only if they discharge into a hopper before distribution.

L. Deposit concrete continuously and in level layers of such thickness (not exceeding 2 feet in depth) so that no concrete will be deposited on concrete that has hardened sufficiently to cause the formation of seams, planes of weakness, or cold joints.

3.4 TIME BETWEEN POURS

A. At least two hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise indicated in the drawings.

3.5 MAXIMUM HEIGHT OF CONCRETE POURS AND FREE FALL

A. Do not drop concrete freely into place from a height greater than 6 feet in unexposed work and 4 feet in exposed work. Use tremies or pumps where the drop exceeds these limits.

3.6 PUMPING CONCRETE

A. Conform to the recommendations of ACI 304.2R except as modified herein.

B. Base pump size on rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lift, and slump of concrete.

C. Minimum inside diameter of pipe or hose shall be based on the maximum aggregate size as follows:

1. 3/4-inch-maximum aggregate: 2 inches minimum inside diameter.

2. 1-1/2-inch-maximum aggregate: 4 inches minimum inside diameter.

D. Do not use aluminum pipes for delivery of concrete to the forms.

E. Before pumping is started, prime the delivery pipe or hose by pumping mortar through the line using 5 gallons of mortar for each 50 feet of delivery line. Do not deposit mortar in the forms.

3.7 HOT WEATHER REQUIREMENTS

A. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 305 and the following.

B. When the weather is such that the temperature of the concrete as placed would exceed 90°F, use ice or other means of cooling the concrete during mixing and transportation so that the temperature of the concrete as placed will not exceed 90°F.

C. Take precautions when placing concrete during hot, dry weather to eliminate early

setting of concrete. This includes protection of reinforcing from direct sunlight to prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.

D. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

3.8 COLD WEATHER REQUIREMENTS

A. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306 and the following.

B. When the temperature of the surrounding atmosphere is 40°F or is likely to fall below this temperature, use heated mixing water not to exceed 140°F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.

C. When placed in the forms during cold weather, maintain concrete temperature at not less than 55°F. All materials shall be free from ice, snow, and frozen lumps before entering the mixer.

D. Maintain the air and the forms in contact with the concrete at temperatures above 40°F for the first five days after placing, and above 35°F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.

E. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

3.9 GROUTING MACHINERY FOUNDATIONS

A. Block out the original concrete or finish off a sufficient distance below the bottom of the machinery base to provide for the thickness of grout shown on the drawings. After the machinery has been set in position and placed at the proper elevation by steel wedges, the space between the bottom of the machinery base and the original pour of concrete shall be filled with a pourable nonshrink grout. Grout and grouting procedure shall be in accordance with API RP 686, Chapter 4, paragraphs 3.6 and 3.7, and Chapter 5.

3.10 BACKFILL AGAINST WALLS

A. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.

B. Do not backfill the walls of structures that will be laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

3.11 CONCRETE TESTS

A. Concrete quality testing will be performed on the concrete by an independent testing

laboratory paid for by the Contractor as follows:

1. Frequency of Sampling: Cast four concrete test cylinders from each 75 cubic yards, or fraction thereof, of each class of concrete placed in any one day. Sampling and curing of cylinders shall conform to ASTM C31.
2. Strength Testing: Test cylinders in accordance with ASTM C39. Test one cylinder at 7 days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.
3. Determine concrete slump by ASTM C143 with each strength test sampling and as required to establish consistency.
4. Determine air content of the concrete using ASTM C231 to verify the percentage of air in the concrete immediately prior to depositing in forms.
5. The average value of concrete strength tests shall be equal to or greater than the specified 28-day strength. No test shall be less than 90% of the specified 28-day strength.
6. If the 28-day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Owner and in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 90% of the specified minimum compressive strength or if any single core is less than 75% of the minimum compressive strength, the concrete will be considered defective. The Owner may require additional coring, nondestructive load testing, or repair of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor at no extra cost to the Owner.

B. To facilitate concrete sampling and testing, the Contractor shall:

1. Furnish labor to assist the testing laboratory in obtaining and handling samples at the project site.
2. Advise the Owner in advance of concrete placing operations to allow for scheduling and completion of quality testing.
3. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.

END OF SECTION

SECTION 03 36 00 - CONCRETE FINISHING AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes materials and methods of concrete finishes, curing, repair of defects, and surface protection.

1.2 REFERENCES

A. Referenced Standards:

1. American Society for Testing and Materials (ASTM)

a. D4263:Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

2. National Sanitation Foundation (NSF)

3. American Concrete Institute (ACI):

a. 301: Specifications for Structural Concrete.

b. 302.1R: Construction of Concrete Floors.

c. 303R: Architectural Cast-in-Place Concrete.

d. 303.1: Architectural Cast-in-Place Concrete.

e. 311.4R: Guide for Concrete Inspection.

1.3 SUBMITTALS

A. Submit product data in accordance with the General Conditions and Section 01 33 00.

B. Submit curing compound manufacturer's statement of compliance with these specifications and recommended coverage to meet or exceed the specified tests. Submit manufacturer's application instructions.

C. For potable water, provide certification that all materials used in the curing and repair of concrete meet the requirements of ANSI/NSF 61 for contact with potable water.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Epoxy Bonding Compound

1. See Section 03 30 00.

B. Curing Compound

1. Curing compound shall conform to ASTM C309, Type 1-D, Class A.

2. Curing compound shall be compatible with required finishes and coatings and shall meet the State of Texas Clean Air Quality Standards which limit the quantity of volatile organic compounds.

C. Mortar for Repair of Concrete

1. Mortar used for repair of concrete shall be made of the same materials as used for concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing.

D. Burlap Mats

1. Conform to AASHTO M182.

E. Sisal-Kraft Paper and Polyethylene Sheets for Curing

1. Conform to ASTM C171.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Concrete Finishes

1. Finish concrete surfaces in accordance with the following schedule:

Finish Designation	Area Applied
F-1	Beams, columns, and exterior walls not exposed to water or view.
F-2	Exterior and interior walls, beams, and columns.
F-3	Walls, beams, and columns of structures or buildings exposed to view or water and to 1 foot below finished grade. Underside of formed floors or slabs. EXCEPTION: surfaces that are to be coated.
F-4	Exterior and interior surfaces to be coated.
S-2	Slabs and floors not water bearing.

S-3	Slab surfaces on which mechanical equipment moves. Slab surfaces to receive hardener and Section 03351.
S-4	Slabs and floors of structures or buildings which are water bearing.
S-5	Slabs and floors at slopes greater than 10% and stairs.
E-1	Exposed edges. EXCEPTION: edges normally covered with earth.
E-2	Top of walls, beams, and similar unformed surfaces.

2. Finish F-1: Repair defective concrete, fill depressions deeper than 1/2 inch, and fill tie holes.

3. Finish F-2: Repair defective concrete, remove fins, fill depressions 1/4 inch or deeper, and fill tie holes.

4. Finish F-3: In addition to Finish F-2, light sandblast to open "bug holes," fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and one and one-half parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.

5. Finish F-4: Repair defective concrete, remove fins, fill depressions 1/16 inch or deeper, fill tie holes, remove mortar spatter, and remove bulges higher than 1/16 inch.

6. Finish S-2: Smooth steel trowel finish.

7. Finish S-3: Steel trowel finish free from trowel marks and all irregularities.

8. Finish S-4: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.

9. Finish S-5: Steel trowel finish without local depressions or high points. Apply a stiff bristle broom finish. Leave broom lines parallel to the direction of slope drainage.

10. Finish E-1: Provide chamfer or beveled edges per Section 03 15 00.

11. Finish E-2: Strike smooth and float to an F-3 or F-4 finish.

B. Finishing of Formed Surfaces

1. Water cure surfaces until finishing and repairing are completed.

2. Perform finish work as soon as possible after forms are removed. Remove fins and irregularities by grinding or rubbing, fill depressions deeper than specified with mortar, and fill tie holes.

3. Ream tie holes with toothed reamers until surface of hole is rough and clean. Coat surface with epoxy bonding compound and fill with mortar.

C. Finish tapered tie holes as follows:

1. Sandblast tie rod hole and blow clean prior to filling.

2. Drive rubber plug, with one end open, to the center of the hole. Plug size shall be larger in diameter than the diameter of the hole at the center of the wall.

3. Coat entire annular surface of the hole with epoxy prior to filling with mortar. Apply epoxy in accordance with manufacturer's instructions.

4. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.

5. Notify Owner's Representative of tie rod filling schedule.

D. Repair of Defects

1. Do not repair defects until concrete has been reviewed by the Owner's Representative.

2. Surface Defects:

a. Repair surface defects that are smaller than 1 foot across in any direction and are less than 1/2 inch in depth.

b. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8 inch deep, thoroughly dampen the surface, work into the surface a bonding grout (one part cement to one part fine sand), fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.

E. Severe Defects:

1. Repair severe defects that are larger than surface defects but do not appear to affect the structural integrity of the structure.
2. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges of the hole perpendicular to the surface, sandblast the surface, coat the sandblasted surface with epoxy bonding compound, place non-shrink grout as specified in Section 03 30 00, match the finish on the adjacent concrete, and cure as specified.

F. Major Defects:

1. If the defects are serious or affect the structural integrity of the structure or if patching does not satisfactorily restore the quality and appearance to the surface, the Owner's Representative may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

F. Repair of Cracks in Concrete

1. Repair concrete cracks in liquid containment structures that are greater than 0.01 inch in width by epoxy pressure injection.

2. Preparation: Insert and anchor a one-way polyethylene valve or pipe nipple in holes drilled into crack. Position them every 6 inches or 18 inches on center depending on the width of the crack. The injecting operation for vertical cracks shall consist of pumping the epoxy grout into the lowest position first and working vertically up in the cracks. Maintain a slow, steady pressure rather than a rapid buildup of pressure. When grouting material reaches the next tube, stop off the present position and follow the same procedure on the next position.

3. Upon completion of the epoxy grouting, remove the epoxy gel used to hold the valve or nipple by applying a direct flame to the epoxy and scraping it off. Fill the holes with the same material as used for patching the surface.

4. While the valves or nipples are installed first, the grouting operation shall not commence until after the patchwork has been completed and has sufficiently cured.

5. Repair cracks in nonhydraulic concrete structures that are wider than 1/10 inch by cutting out a square edged and uniformly aligned joint 3/8 inch wide by 3/4 inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant in accordance with Section 03 15 00.

6. If the cracks are serious or affect the structural integrity or function of the element, the Owner's Representative may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

7. After leakage testing per Section 03 05 00, dewater the structure, repair leaking concrete cracks from inside the structure, and retest the structure.

G. Curing and Protection

1. Water cure cast-in-place concrete for liquid containment walls, slabs, channels, and footings by Method 1, 2, or 3 for a period of five days (minimum) prior to applying other curing methods. Do not submerge concrete placed in the dry until it has attained sufficient strength to adequately sustain the stress involved and do not subject it to flowing water across its surface until it has cured fir five days. Start curing of concrete as soon as possible without damaging surface and not later than two hours after placing.

2. Cure concrete surfaces in accordance with the methods specified herein for the different parts of the work and described in the following paragraphs. These methods are considered to be minimum for curing. The conditions that exist in the field during placement and curing may require additional curing procedures and efforts to ensure proper protection and curing of the concrete. Select and implement the appropriate method commensurate with climatic conditions.

Curing Method	Area Permitted
1	All surfaces.
2	All surfaces.
3	Slabs and floors.
4	All surfaces when maximum ambient temperature will not exceed 80°F and humidity will not drop below 40% on the day of concrete placement and for the three days following.

3. Where wooden forms are used, wet forms immediately before concreting and keep moist by sprinkling until removed. Keep exposed surfaces of formed concrete moist until commencement of curing.

4. Use proper concrete placing and curing methods at all times to limit the amount of crazing and cracking of the structures during initial setting and shrinking of the concrete.

5. Cure all concrete for not less than 14 days after placing in accordance with one of the following methods.

   a. Method 1, Water Spray Method:

      Tightly close off concrete surfaces to be cured by bulkheads or other means or entirely surround by tight enclosures, and keep the concrete surfaces moist by sprinkling, spraying, or other means.

   b. Method 2, Wet-Burlap-Mat Method:

      Thoroughly wet and cover concrete surfaces to be cured with wet burlap mats as soon as the forms have been stripped or as soon as the concrete has set sufficiently to avoid marring the surface. Keep entire concrete surface and burlap continuously and completely wet during the entire curing period.

   c. Method 3, Curing Blanket Method:

      Thoroughly wet concrete surfaces to be cured and cover with curing blankets as soon as the concrete has set sufficiently to avoid marring the surface. The curing blankets shall be weighted to maintain close contact with the concrete surface during entire curing period. Should the curing blankets become torn or otherwise ineffective, keep surfaces moist and replace damaged sections. The curing blankets shall consist of one of the following two types:

      Sheets of heavy waterproof sisal-kraft paper laid with the edges butted together and with the joints between strips sealed with 2-inch-wide strips of sealing tape or with the edges lapped not less than 3 inches and fastened together with waterproof cement to form continuous watertight joints; or sheets of clean polyethylene, having a minimum thickness of 4 mils, laid with edges butted together, and with the joints between sheets sealed with 1-inch- wide strips of acetate tape. During the curing period, do not permit traffic of any nature or depositing of objects, temporary or otherwise, on the curing blankets.

   d. Method 4, Curing Compound Method:

      Do not use curing compound on surfaces that are to be coated with clear floor hardener.

      Spray the surface with two coats of liquid curing compound. Apply in accordance with the manufacturer's instructions to cover the surface with a uniform film that will seal thoroughly. Apply second coat at 90 degrees from the first coat.

      Apply curing compound immediately after completion of the finish on unformed surfaces and within two hours after removal of forms on formed surfaces. Repair formed surfaces within the said two-hour period; provided, however, that any such repairs which cannot be made within the said two-hour period shall be delayed until after Method 1, 2, or 3 has been applied. When repairs are to be made to an area on which curing compound has been applied, first sandblast the area to remove the compound, then repair.

      Wherever curing compound may have been applied to surfaces against which concrete subsequently is to be placed and to which it is to adhere, remove the curing compound entirely by sandblasting prior to the placing of new concrete.

      Where the curing compound method is used, exercise care to avoid damage to the seal

during the curing period. Should the seal be damaged or broken before the expiration of the curing period, repair the damaged portions immediately by the application additional curing compound.

6. It is the responsibility of the Contractor to select the appropriate curing method in response to climatical and/or site conditions occurring at the time of concrete placement. Take appropriate measures as described in ACI 305 and 306 for protecting and curing concrete during hot and cold weather.

END OF SECTION

SECTION 03 41 00 - PRECAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all materials, labor, and equipment and construct manholes, wet wells, valve pits, meter pits, and accessory items, consisting of precast sections as shown on the Drawings and as specified herein.

B. The forms, dimensions, concrete, and construction methods shall be approved by the ENGINEER in advance of construction.

C. These specifications are intended to give a general description of what is required, but do not purport to cover all of the structural design details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, shop testing, delivery, and complete installation of all precast structures whether specifically mentioned in these specifications or not.

D. The supplier of the precast manholes, wet wells, valve pits, meter pits, and accessory items shall coordinate his work with that of the CONTRACTOR to the end that the unit will be delivered and installed in the excavation provided by the CONTRACTOR, in accordance with the CONTRACTOR's construction schedule.

E. Coordinate the precast structures fabrication with the equipment supplied to achieve the proper structural top slab openings, spacings, and related dimensions for the selected equipment frames and covers. The top slabs, frames, covers, and subsurface structures shall be capable of supporting a live load of 150 pounds per square foot.

1.2 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions and Section 01 33 00.

B. Submit structural or buoyancy calculations as required.

C. Manufacturer's Literature: Manufacturer's recommended installation instructions

D. Manufacturer's certificates of material conformance with specifications.

1.3 INSPECTION

A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the ENGINEER, or other representatives of the OWNER. Such inspection may be made at the place of manufacture, or at the site after delivery, or at both places, and the sections shall be subject to rejection at any time on account of failure to meet any of the Specification requirements; even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the job shall be marked for identification and shall be removed from the job at once. All sections which have been damaged after delivery will be rejected, and if already installed, shall be repaired, if permitted and accepted by ENGINEER, or removed and replaced, entirely at the CONTRACTOR's expense.

B. At the time of inspection, the sections will be carefully examined for compliance with ASTM C478 designation and these Specifications, and with the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

C. Imperfections may be repaired, subject to the approval of the ENGINEER, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days, Epoxy mortar may be utilized for repairs subject to the approval of the ENGINEER.

PART 2 – PRODUCTS

2.1 PRECAST CONCRETE WET WELLS AND VALVE VAULTS

A. Precast submersible pump station wet wells shall consist of precast base, precast wet well sections, and top cover slab unless noted otherwise. Precast valve vaults shall consist of precast base, sidewalls and top slab. Concrete shall be air entrained at the time of delivery and shall have a minimum compressive strength of 5,000 psi at the end of 28 days.

B. Joints between precast concrete sections shall be gasketed and filled with non-metallic non-shrink grout as shown on the drawings.

C. The top slab sections shall be fitted with water tight hatches. The frames and covers will be sized for the openings shown on the drawings.

D. The various precast sections should have the inside dimensions and minimum thickness of concrete as indicated on the drawings. All precast and cast-in-place concrete members shall conform to the Building Code Requirements for Reinforced Concrete ACI 318.

E. A vent pipe shall be furnished and installed as shown on the drawings.

F. Fillets shall be provided and installed in the wet wells as shown on the drawings.

G. Precast structures shall be constructed to the dimensions as shown on the drawings and as specified in these Specifications.

H. Type II cement shall be used except as otherwise approved.

I. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast section.

J. Sections shall be cured by an approved method and shall not be shipped until the minimum 7-day compressive strength has been attained.

K. Each pre-cast section manufactured in accordance with the drawings shall be clearly marked to indicate the intended pump station installation location. The CONTRACTOR shall be responsible for the installation of the correct pre-cast sections in their designated pump station locations.

L. Paint all exterior surfaces with two coats of coal tar bitumastic, each coat to be 9 mils each. All interior surfaces of valve vaults shall be coated with two coats of coal tar epoxy (9 mils each).

2.2 PRECAST CONCRETE SECTIONS FOR CIRCULAR WET WELLS

A. Wet wells shall meet the requirements of ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections, with the exclusion of Section 10(a), except as modified herein. Cement shall meet the requirements of ASTM C150-74, Specification for Portland Cement, Type II. Concrete shall meet the minimum requirement for 5,000 psi concrete. Minimum wall thickness shall be 10 inches or 1/8 the inside manhole diameter as shown, whichever is greater. The required minimum strength of concrete shall be confirmed by making and testing three standard cylinders at seven days. Rings shall be custom made with openings to meet indicated pipe alignment conditions and invert elevations. Submit shop drawings, consisting of manufacturers' standard details of various sections for approval prior to placing order for wet wells. Drawings of individual wet wells showing invert elevations, pipe sizes and similar details will not be required.

B. Joints:
Form joint contact surfaces with machined castings. Surfaces shall be exactly parallel with nominal 1/16 inch clearing and the tongue equipped with a proper recess for the installation of an O-ring rubber gasket. Gaskets shall meet the requirements of Specification for Joint for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

C. Wet well Liners and Coatings:
Coat or line the interior of all wet wells as noted on the contract drawings. Furnish, install, test and inspect liners and coating in accordance with manufacturer’s recommendations. Extend coating and liner and seal onto wet well hatch frame, around pipe openings and other protrusions to prevent contact of wet well surface with corrosive sewer gases.

D. Alternate corrosion protection:
When indicated on the contract drawings, concrete used for precast wet wells shall include admixtures to prevent microbial induced corrosion and acid attack. Admixture shall be Xypex Bio-San C500.

2.3 PIPE CONNECTIONS AT STRUCTURES

A. Where pipes are to extend into or through structures from the exterior, flexible connections (mechanical or push-on type joints) shall be provided at the exterior wall face.

B. For pipes passing through structural walls, wall pipes with water stops shall be installed where the location is below the surface of the ground or at any point where fluid levels will exceed that elevation. Neoprene sleeves with watertight caulking and 316 Series SS stainless steel clamps will be suitable at other locations or where shown on the contract drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The CONTRACTOR shall be responsible for control of ground water to provide firm, dry subgrade for the structure, to prevent water rising on newly cast in place concrete or recently grouted joint sections. Dewatering system shall guard against flotation or other damage resulting from ground water or flooding.

B. A minimum 12 inch layer of crushed stone shall be placed as a foundation for the wet well base slabs, valve pits, and meter pits or as shown on the contract drawings.

C. Backfill material around the wet well and above the pipe bedding shall be selected material as specified in the contract drawings or the geotechnical report.

D. Precast bases, conforming to all requirements of ASTM C478 and above listed requirements for precast sections, may be used. The base shall be set in place on a thoroughly compacted crushed stone sub-base and adjusted in grade for the correct structure elevation.

E. The station shall not be set into the excavation until the installation procedure and excavation have been approved by the ENGINEER.

F. The base may be cast-in-place concrete as specified in Division 3, placed on a thoroughly compacted crushed stone sub-base. The tops of the cast-in-place bases shall be shaped to mate with the precast barrel section, and shall be adjusted in grade so that the top slab section is at the approximately correct elevation

G. Precast concrete structure sections shall be set vertical and with sections in true alignment with a 1/4 inch maximum. The outside and inside joint shall be filled with a non-shrink grout and finished flush with the adjoining surfaces. Allows joints to set for 24 hours before backfilling. Backfilling shall be done in a careful manner, bringing the fill up evenly on all sides. Install the precast sections in a manner that will result in a watertight joint.

H. Holes in the concrete sections required for handling or other purposes shall be plugged with a non-shrinking grout or by grout in combination with concrete plugs.

I. Where holes must be cut in the precast sections to accommodate pipes, cutting shall be done by core drilling prior to setting them in place to prevent any subsequent jarring which may loosen the mortar joints.

END OF SECTION

SECTION 09 90 00 - PAINTING AND COATING

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and field application of paints and other coatings.

B. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified under other Sections.

C. Paint exposed surfaces except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Owner shall select from standard colors or finishes available.

D. Painting includes field painting exposed pipes (including color coding), exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment. It shall include exposed piping, and all exposed exterior equipment which is delivered shop- primed or unfinished. This includes all items except those listed below that do not require to be painted.

E. Painting includes field painting of all exposed structural elements including but not limited to structural steel, joists, beams, columns, structural accessories, and miscellaneous metals.

F. Painting includes all carbon steel tankage. All exterior tank surfaces, including underside of tank, shall be coated per Exterior Ferrous Metal section of the Paint Schedule. Interior of tankage shall be coated per Immersed Ferrous Metal section of the Paint Schedule.

G. Painting also includes field painting of doors, frames, access panels, window frames, gypsum wallboard, louvers, vents, accessories, and other items identified in the Contract Documents and not indicated to be left un-painted.

H. All new above grade process piping and fittings (except stainless steel) shall be painted. All existing process piping, fittings, supports, valves, or equipment disturbed, moved, or chipped during construction shall be properly prepared and painted.

I. Painting is not required in existing buildings, rooms, or existing tankage, unless otherwise noted in the specifications or on the drawings. However, the Contractor shall touch-up all existing areas disturbed during construction. All penetrations that get filled in shall be coated to match adjacent areas.

1.2 Painting is not required on pre-finished items, finished metal surfaces, specific concealed surfaces, operating parts, labels, and nameplates.

1.3 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   2. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
   3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SEQUENCING

A. Back prime wood trim before installation of trim.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:
   1. Submit manufacturer data on finishing products, special coatings and primers.
   2. Include MPI - Approved Products Lists with proposed products highlighted.

C. Samples:
   1. Submit two full manufacturer color charts available for each surface finishing product as scheduled.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special surface preparation procedures, substrate conditions requiring special attention, and environmental conditions.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
   1. Submit qualifications for manufacturer and applicator.
   2. Submit manufacturer's approval of applicator.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of painted and coated surfaces.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:
   1. Furnish 1 gallon of each color and type of paint provided for the Project.
   2. Label each container with manufacturer's label, color, type, texture, room number, Site location and structure.
   3. Store were directed by Owner and in compliance with manufacturer recommendations.

1.8 QUALITY ASSURANCE

A. MPI Standards:
   1. Comply with indicated MPI standards.
   2. Products: Listed in MPI - Approved Products List.

B. Single-Source Responsibility: Whenever possible, provide primers and undercoat paint produced by the same manufacturer as the finish coats.

C. Shop Primed Surfaces: Verify that manufacturer applied primer coatings are compatible with finish coating products.

D. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

E. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Painted material containers not displaying the manufacturer’s product identification will not be acceptable. Use only new paint.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 20 years of experience.

B. Applicator: Company specializing in performing Work of this Section with minimum 5 years of experience and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Container Labeling: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

B. Inspection:
   1. Accept materials on Site in manufacturer's sealed and labeled containers.

2. Inspect for damage and to verify acceptability.

C. Store materials in ventilated area and otherwise according to manufacturer instructions.

D. Protection:
1. Protect materials from moisture and dust by storing them in clean, dry locations away from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Storage Conditions:
1. Minimum Ambient Temperature: 45 degrees F.
2. Maximum Ambient Temperature: 90 degrees F

B. Application Conditions:

1. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint manufacturer. Do not apply exterior coatings during rain or snow, when relative humidity is outside humidity ranges, or when moisture content of surfaces exceeds those required by paint manufacturer. Minimum Application Temperatures for Paints: 45 degrees F for interiors and 50 degrees F for exteriors, unless otherwise indicated by manufacturer instructions.
2. Lighting Level: 80 fc measured mid-height at substrate surface.

1.12 WARRANTY

A. Furnish a five-year manufacturer's warranty for paint and coatings.

PART 2 - PRODUCTS

2.1 PAINTS AND COATINGS

A. Manufacturers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include but are not limited to the following: Tnemec Co. Inc.

B. General: The number of coats listed on this schedule is the total number of coats required on the material. The first coat primer (when three coats are required) may be omitted on items delivered shop primed, if approved in advance in writing by Architect/ Engineer. Apply specific number of coats to bare surfaces.

C. See other Sections under Part 2 of this Specification or refer to the drawings for special coatings to be applied in certain areas not to be coated per the painting system schedule. All items shall be coated per the painting schedule unless otherwise noted.

D. Paint Schedule:

1. EXTERIOR FERROUS METAL
   a. Surface Preparation: SSPC SP-6 Commercial Blast Cleaning. Shop primed and coated items shall be completely clean of rust, loose paint, oils, mill scale, and dirt.
   b. First Coat: Induron Indurazinc MC67, 2.5 to 3.5 dry mils (DFT)
   c. Second Coat: Induron Perma-Clean II, 3 to 5 mils DFT
   d. Third Coat: Induron Indurathane 6600 Plus, 2 to 3 mils DFT

2. EXTERIOR, ABOVE GRADE, VERTICAL CONCRETE WALLS AND BLOCK FACES
   a. Clear penetrating sealer.
   b. Surface Preparation: Allow vertical concrete walls to cure 28 days minimum. Pressure wash at 2000-3000 psi. All areas shall be prepared to a clean, dry surface free of chalk, dust dirt, oils, grease, and release agents.
   c. First Coat: L & M “Hydropel WB”, 75-125 sq ft. per gallon; or Tnemec Chemprobe Series 633 Prime-A-Pell H_2O, 75-125 sq. ft. per gallon (per manuf. dependent on application).
   d. Second Coat: repeat first coat.

3. IMMERSED CONCRETE TANKAGE FOR RAW WASTEWATER
   a. Includes all interior floors, walls and ceilings (if applicable). Tankage includes all new and/or renovated equalization tanks, headworks channels and wet wells.
   b. Surface Preparation: Verify dryness by testing for moisture with a “plastic film tape-down test” (ASTM D 4263). Abrasive blast to remove all laitance, form release agents, existing coatings, and contaminants in accordance with SSPC-SP 13/NACE 6, ICRI CSP-4. All surfaces shall be fully cured a minimum of 28 days, clean and dry.
   c. First Coat: calcium aluminate mortar, Sewpercoat, Refratta HAC 100, or Engineer approved equal, 1” minimum thickness.

4. IMMERSED FERROUS METALS, INTERIOR OF WASTEWATER TANKS OR PIPES
   a. Surface Preparation: SSPC SP-10, Near White Metal Blast Cleaning with a 1 - 3 mil minimum anchor profile. Clean and dry.
   b. First Coat: Coal Tar Epoxy Polyamide, Induron Ruff-Stuff 2100 or equal, 12 mils DFT
   c. Second Coat: repeat first coat, 24 mils Total DFT.

5. IMMERSED HOT DIPPED GALVANIZED STEEL (12” above and below water line)
   a. Surface Preparation: SSPC-SP-1 Solvent Cleaning
   b. First Coat: Coal Tar Epoxy Polyamide, Induron Ruff-Stuff 2100 or equal, 12 mils DFT
   c. Second Coat: repeat first coat, 24 mils Total DFT.

6. INTERIOR FERROUS AND NON-FERROUS METALS:
   a. Surface Preparation: SSPC SP-6 Commercial Blast Clean.

b. First Coat: Tnemec Series 1, Omnithane, 2.5 to 3.5 mils DFT
c. Second Coat: Tnemec Series N69 - Hi-Build Epoxoline II, 3 to 5 mils DFT
d. Third Coat: repeat second coat.

7. INTERIOR GALVANIZED METAL:
   a. Surface Preparation: Clean surface, remove pre-treatments with light sweep sand blasting to 1 mil profile. Special care shall be taken not to remove galvanized exterior. Apply Series N69 within 1 hour of surface preparation.
   b. Coating: Same as interior ferrous metals except eliminate first coat

8. INTERIOR CONCRETE BLOCK MASONRY
   a. Surface Preparation: Allow mortar to cure 28 days minimum. All areas shall be prepared to a clean, dry surface free of chalk, dust dirt, oils, grease, and release agents.
   b. First Coat: Tnemec Series 130-6601, Envirofill Block filler, 80-100 square feet per gallon
   c. Second Coat: Tnemec Series N69 Hi-Build Epoxoline II, 3.0-5.0 mils DFT
   d. Third Coat: same as second coat

9. INTERIOR CONCRETE WALLS
   a. Surface Preparation: All areas shall be prepared to a clean, dry surface free of chalk, dust dirt, oils, grease, and release agents. Abrasive blast existing tankage per item (6.a) prior to conversion into occupied space.
   b. Filler and Sufacer: Resurface existing tankage per item (6.b) prior to coating application.
   c. First Coat: Tnemec Series 6, Tneme-Cryl, 2.0 - 3.0 mils DFT
   d. Second Coat: same as first coat
   e. Third Coat: same as second coat

10. INTERIOR CONCRETE / PRECAST PLANK CEILINGS
   a. Surface Preparation: All areas shall be prepared to a rough, clean, dry surface free of chalk, dust dirt, oils, grease, and release agents.
   b. First Coat: Tnemec Series 180/181, WB Tneme-Crete, 4.0 to 8.0 mils DFT (apply both coats across the width of the plank).
   c. Second Coat: same as first coat

11. INTERIOR GYPSUM WALLBOARD
   a. Surface Preparation: All areas shall be prepared to a rough, clean, dry surface free of chalk, dust, dirt, oils, grease and release agents.
   b. First Coat: Sherwin Williams ProMar 200 Zero VOC Latex Primer, 1 mil DFT.
   c. Second Coat: Sherwin Williams ProMar 200 Zero VOC Latex Semi-gloss, 1.0 – 2.0 mils DFT.
   d. Third Coat: same as second coat.

12. INTERIOR WOOD / LUMBER
   a. Surface Preparation: All areas shall be prepared to a rough, clean, dry surface free of chalk, dust dirt, oils, grease, and release agents.
   b. First Coat: Tnemec Series V10 (gray-1009), 2.0-3.0 mils DFT

c. Second Coat: Tnemec Series 6 Tneme-Cryl, 2.0 – 3.0 mils DFT
d. Third Coat: same as second coat

13. INTERIOR CONCRETE FLOORS – SEALED
    a. Surface Preparation: Apply as soon as possible after floor is walkable and control joints are cut (shall be applied no later than 12 hours after floor is poured). Prepare per manufacturer's recommendations.
    b. Coating: Apply Ashford Formula or L & M "Seal Hard". Installing Contractor shall be certified by manufacturer in writing. Provide 20-year warranty for materials & 5-year warranty for labor.
    c. Contractor shall include in bid for a final cleaning of all floors treated with Ashford Formula or equivalent hardener. Final cleaning shall be with a mechanical floor polishing machine using Nylo-Grit brushes and high pH cleaning solution to completely remove dirt & dust from floor.

14. CHEMICAL ROOM CONTAINMENT AREA
    a. Surface Preparation: Allow new concrete to cure 28 days. Verify dryness by testing for moisture with a "plastic film tape-down test (ASTM D 4263). Should moisture be detected perform "Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride" (ASTM F 1869). Moisture content not to exceed 3 pounds per 1,000 sq ft in a 24-hour period. Abrasive blast clean in accordance with NACE 13/NACE 6, ICRI 3-5. Vacuum all debris clean and dry.
    b. Filler and Surfacer: Tnemec Series 215 Epoxy, hand apply to all holes, spalls, cracks, and severely roughened areas.
    c. Reinforcement: Reinforce all joints between walls, walls, and floor and between pads and floor. Apply Tnemec Series 239SC ChemTread, 8.0-10.0 mils DFT in a 3-inch-wide application on the horizontal and vertical surfaces of the joints described above. Place a 4-inch-wide strip of ¾ oz. chopped strand fiberglass mat into the wet Series 239SC so 2 inches are on the vertical and 2 inches are on the horizontal. Smooth so that no bubbles or wrinkles remain. Apply a 3-inch-wide coat of Series 239SC, 8.0-10.0 mils DFT to the previously coated areas to completely saturate the fiberglass mat. Within 24 hours install a cant cove of Tnemec Series 215 Filler and Surfacer over the reinforced joints.
    d. First Coat: Apply Tnemec Series 239SC ChemTread, 160-200 sq ft per gal to all interior surfaces of the containment area.
    e. Second Coat: Apply Tnemec Series 239SC ChemTread, 160-200 sq ft per gal to all interior surfaces of the containment area.
    f. Third coat: Apply Tnemec Series 282 Tneme-Glaze, 160-200 sq ft per gal to all interior surfaces of the containment area.
       Note: The recoat window for the Series 239SC ChemTread and Series 282 Tneme- Glaze is a maximum of 24 hours. Should the recoat window be missed the previously applied coat must be completely scarified with 100 grit aluminum oxide grit sandpaper.

15. INTERIOR AND EXTERIOR, ABOVE GROUND, EXPOSED PVC PIPE

    a. Surface Preparation: Roughen surface of PVC pipe and fittings with 100 grit aluminum

oxide sandpaper, removing gloss. All areas to be prepared to a clean, dry surface free of dust, dirt, oils and grease.

b. First Coat: Tnemec Series 1095 Endura-Shield, 2.0 – 3.0 mils DFT.
c. Second Coat: Same as first coat.
d. Third Coat: Tnemec Series 700 HydroFlon, 2.0 – 3.0 mils DFT.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

B. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION

A. Area Preparation:
   1. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
   2. Protect existing or new equipment and items not to be painted. Construct protective housing as required to prevent damage from the preparation of adjacent areas and to protect from paint splatters.
   3. Construct temporary moisture barrier and heat retention structures as required to maintain proper application conditions.
   4. Schedule cleaning and painting so that dust and other contaminants from adjacent areas will not contaminate wet, newly painted surfaces.

B. Surface Preparation: Refer to this section of the specifications and the painting schedule for minimum surface preparation requirements for each area and coating application. In addition, clean and prepare surfaces to be painted in strict accordance with the manufacturer's instructions and/or recommendations for each substrate condition and coating application.
   1. Provide barrier coats over incompatible primers (or finish coats) or remove and re-prime. Notify Architect/Engineer in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.
   2. Prepare all materials and surfaces to be coated by removing efflorescence, chalk, dust, dirt, grease, oils, release agents, mill scale, and any other foreign substances. Roughen as required

to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

3. Wood: Sand surfaces exposed to view smooth and dust off. Apply a knot sealer before application of primer where necessary. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried. Apply primer to wood surfaces immediately after completion of installation.
4. Areas damaged by surface preparation shall be the responsibility of the contractor and shall be fully replaced, re-installed, and placed back in operation by the contractor at no expense to the owner.

C. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.

1. 1Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before use.
3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

D. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat. Failure of the Architect/Engineer to distinguish among coats may result in their recommendation to reject painting as incomplete.

E. All painting and coatings shall be applied prior to sealants and caulks unless otherwise noted.

3.3 APPLICATION

A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

C. Provide finished coats that are compatible with primers used.

D. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

E. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.

F. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment. The Architect/Engineer may require removal of built-in equipment to observe painting in hidden areas.

G. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint, min. 6" into duct.

H. Finish exterior doors on tops, bottoms, and side edges same as exterior faces.

I. Allow sufficient time between successive coats to permit proper drying per manufacturer's recommendations. Do not recoat until the paint has dried to where it feels firm and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

J. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide total dry film thicknesses per painting schedule as a minimum. Additional thicknesses shall be provided when recommended by the manufacturer.

K. Paint exterior wall-mounted equipment, including louvers, same color as adjacent exterior wall. Paint exterior roof top equipment scheduled to be painted same color as roof at sloped-roof areas and same color as nearest exterior wall at flat roof areas, or as selected by Architect/Engineer.

L. Block Fillers: Apply block fillers to concrete masonry block to ensure all voids, holes, and cracks are filled.

M. Rejection of work:
   1. Painting not in accordance with approved paint colors or textures may be rejected and the contractor shall be required to completely remove and replace defective areas.
   2. Drips, runs, splatters, peeling, and overall sloppy workmanship shall be grounds for rejection of work. Work rejected shall be completely removed and replaced. Adjacent areas affected by paint splatters, drips, etc. shall be completely cleaned by the contractor or the areas by-prepared and re-coated by the engineer. Areas damaged by paint shall be the responsibility of the contractor.

3.4 FIELD QUALITY CONTROL

A. The Owner and/or Engineer may require the following test procedure at any time and as often as the Owner deems necessary during the period when paint is being applied:
   1. The Contractor or Supplier will engage the services of an independent testing laboratory to sample the paint material being used. Samples of material delivered to the project will be taken, identified, sealed, and certified in the presence of the Contractor. The testing laboratory may also observe finished painted surfaces in any part of the project site at any time.
   2. The testing laboratory will perform appropriate tests for the following characteristics as required by the Owner or Engineer:

a. Surface preparation.
b. Dry film thickness.
c. Holiday testing using high voltage spark tester.

3. If test results show material being used does not comply with specified requirements, the Contractor may, at no cost to the Owner or increase in the time to complete the project, be directed to stop painting, remove non-complying paint, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces.
4. If testing indicates non- compliance with specifications or any other inadequacy, additional testing expenses in the same area will be paid by the Contractor at no cost to the Owner or Engineer.

3.5 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site. Take all reasonable precautions necessary to minimize the risk of fire or other potential damage to the project site.

B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

3.6 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing, or replacing, and repainting, as acceptable to Architect/Engineer, at no cost to the Owner, other Contractors or Architect/Engineer.

B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces, at no cost to Owner or Architect/Engineer.

D. Turn over to Owner extra paint materials required in Part 1 of this Section.

3.7 PIPING COLOR SCHEDULE

PROCESS	COLOR OF PIPE
Potable Water	Light Blue
Compressed Air	Light Green
Instrument Air	Light Green with Dark Green Bands
Chlorine (gas, liquid, or vent)	Yellow
Chlorine (solution)	Yellow with Red Bands
Liquid Alum	Yellow with Orange Bands

Alum (solution)	Yellow with Green Bands
Ammonia	Yellow with Brown Bands
Chlorine Dioxide (solution)	Yellow with Blue Bands
Ferric chloride	Brown with Red Bands
Ferric sulfate	Brown with Yellow Bands
Polymers	White with Green Bands
Liquid caustic	White with Red Bands
Caustic (solution)	White with Orange Bands
Fluoride	White with Yellow Bands
Ozone	Stainless Steel with White Bands
Settled Water	Green
Filter Effluent	Light Blue
Backwash Supply	Light Blue
Backwash Waste	Dark Grey
Drain	Dark Grey
Raw Water	Tan
Reclaimed Water	Purple with Black Lettering
Effluent After Clarification	Dark Green
Sewage	Grey
Sludge	Brown

END OF SECTION 09 90 00

SITE CLEARING

PART 1 GENERAL

1.01 Section Includes

A. Clearing and grubbing.

B. Selective removal and trimming.

C. Debris removal.

1.02 Related Requirements

A. Section 01 5713 - Temporary Erosion and Sediment Control.

B. Section 31 1000.10 - Tree Protection.

D. Section 31 2200 - Grading.

E. Section 31 2323 - Fill.

1.03 REFERENCE STANDARDS -- NOT USED

1.04 SUBMITTALS -- NOT USED

A. Clearing Firm Qualification Statement: Documentation of specialized experience.

1.05 Quality Assurance

A. Clearing Firm Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

B. State and local laws and code requirements shall govern the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter.

C. Contractor shall not clear site until a permit is obtained from the authorized regulatory agency.

D. Air pollution caused by dust and dirt shall be controlled and comply with governing regulations.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 Examination

A. Remove from site and satisfactorily dispose of all trees, shrubs, stumps, roots, brush, masonry, rubbish, scrap, debris, pavement, curbs, fences and miscellaneous other structures required to permit construction of new work.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 Preparation

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain and pay for required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are to remain.

3.03 Clearing and Grubbing

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, landscape areas, and planting beds.

B. Clear site after relocating vegetation in accordance with ANSI A300 Part 6.

C. Do not remove or damage vegetation beyond limits indicated on drawings.

D. Install substantial, highly visible chain link or orange mesh fences at least 4 feet high to prevent inadvertent damage to vegetation at the removal limits. Reference tree protection detail in drawings.

E. In areas where vegetation must be removed but no construction will occur, remove vegetation with minimum disturbance of the subsoil.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, unless indicated on drawings.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed.
   3. Existing Stumps: Treat as specified for other vegetation removed; completely remove stumps and roots to depth of 6 inches below subgrade.
   4. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner. Contractor shall warrant damaged vegetation for 18 months.

3.04 Selective Removal and Trimming

A. Selective Removal: Individual tree and shrub identified for removal as indicated on drawings according to 29 CFR 1910.266.

B. Selective Trimming: Individual limbs and branches cut back according to ANSI A300 Part 1 identified for removal as indicated on drawings. Follow recommendations of ANSI Z133 and best local practices for species involved.

3.05 Removed Vegetation Processing

A. Do not burn, bury, landfill, or leave on-site, except as indicated on drawings.

B. Trees: Sell if marketable.

3.06 Debris Removal

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and windblown debris from public and private lands.

END OF SECTION

TREE PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Protection of Existing Trees.

1.02 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing.

B. Section 31 2200 - Grading.

1.03 PRICE AND PAYMENT PROCEDURES

A. Tree Protection Fence: By the linear foot. Includes chain link or plastic mesh fence, posts, tie wire, and installation.

1.04 REFERENCE STANDARDS

A. ANSI A300-2008 Pruning.

B. Local Municipal Code.

1.05 SUBMITTALS -- NOT USED

1.06 QUALITY ASSURANCE

A. Employ certified arborist or landscape architect to supervise or perform tree protection work as required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Tree Protection Fence: 4 feet high galvanized chain link.
   1. Posts: 1-1/2 inch at 6 feet on center, 2 feet deep.
   2. Tension Wire: Not less than 12 gauge at top and 6 inches above existing grade.

B. Tree Protection Fence: 4 feet high heavy gauge orange plastic mesh with 2" openings.
   1. Posts: "T" posts at 6 feet on center, 2 feet deep.

PART 3 EXECUTION

3.01 TREE PROTECTION FENCE

A. Install at Root Protection Zone of all existing trees to be protected as shown on drawing.

B. Root Protection Zone shall be located 1 foot radius from trunk for every 1 inch diameter of trunk at 4 feet from ground. The diameter of a multi-trunk tree is calculated as the sum of the largest trunk plus half of the sum of additional trunks at 4.5 feet from ground.

C. Fence may be located a minimum of half of the root protection radius if approved by the regulatory authority, Engineer, or Owner.

D. Fence Location Detail: See detail as shown on drawings.

3.02 TREE PROTECTION REQUIREMENTS

A. Install tree protection fence prior to any clearing, excavation, or grading and maintain in good repair for the duration of all construction work unless otherwise directed**.**

B. No construction operations are allowed within the Root Protection Zone.

C. Root Protection Zone shall be sustained in a natural state and shall be free from vehicular or mechanical traffic; no fill, equipment, liquids, or construction debris shall be placed inside the protective barrier.

D. Root Protection Zone shall be covered with 6" of mulch to reduce moisture stress.

E. The proposed finished grade and elevation of land within the Root Protection Zone of any trees to be preserved shall not be raised or lowered more than 3 inches. Welling and retaining methods are allowed outside the Root Protection Zone.

F. Root Protection Zone shall remain pervious, i.e. ground cover or turf at completion of landscape design.

G. No roots may be cut closer than 6 feet from the base of any tree. Roots cut within the Root Protection Zone will only be allowed on one side of the tree. Any roots that need to be cut within the Root Protection Zone will be cut using a saw-type trencher, and all cut roots will be painted.

H. All trees impacted by construction shall be fertilized with an organic tree fertilizer prior to construction and again at the end of construction. The area within the protective fencing shall be mulched with about 6 inches of mulch. Water barrels shall be placed within the Root Protection Zone to irrigate these trees if necessary.

I. No trash or warming fires shall be placed within 50 feet of any tree.

J. No pedestrian traffic shall occur within dripline of any tree.

3.03 DAMAGE TO PROTECTED TREES

A. Trim trees and shrubs when doing so will prevent removal or damage. Trimmed or damaged trees shall be treated or repaired under supervision of a certified arborist or landscape architect.

B. Any damage done to existing tree crowns or root systems shall be repaired immediately under supervision of a certified arborist. All wounds to oaks shall be painted with pruning paint within 20 minutes after damage. Roots exposed during construction operations will be cut cleanly. Cut surfaces shall be painted and topsoil and mulch placed over exposed root area immediately.

C. Branch Pruning Detail: See detail as shown on drawings.

D. Contractor shall compensate owner for damage to existing trees designated to remain in the amount of $200 per caliper inch measured 4 feet from ground. This amount will be deducted from final payment.

END OF SECTION

GRADING

PART 1 GENERAL

1.01 Section Includes

A. Removal of topsoil.

B. Rough grading the site.

C. Fine grading.

D. Finish grading.

1.02 Related Requirements

A. Section 31 1000 - Site Clearing.

B. Section 31 1000.10 - Tree Protection.

C. Section 31 2316 - Excavation.

D. Section 31 2323 - Fill.

E. Project Geotechnical Report.

1.03 Price and Payment Procedures

A. Topsoil:
   1. Measurement Method: By the cubic yard.
   2. Includes: scarifying substrate surface, placing where required, and compacting.

1.04 Submittals

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.05 Quality Assurance

A. Perform Work in accordance with available geotechnical engineering and landscape specifications.

PART 2 PRODUCTS

2.01 Materials

A. Gravel: Excavated on-site.
   1. Graded according to ASTM D2487 Group Symbol GW, GP, or SP.

B. Topsoil: Topsoil excavated on-site; friable loam, imported borrow; local borrow.
   1. Graded.
   2. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.

C. Other Fill Materials: See Section 31 2323.

PART 3 EXECUTION

3.01 Examination

A. Verify survey bench mark and intended elevations for grading areas are as indicated.

B. Verify the absence of standing or ponding water.

3.02 Preparation

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect above- and below-grade utilities to remain.

D. Notify utility company to remove and relocate utilities.

E. Provide temporary means and methods to remove standing or ponding water from areas prior to grading.

F. Protect site features to remain, including but not limited to bench marks, survey control points, and fences.

G. Protect trees to remain. Reference Section 31 1000.10.

H. Protect features to remain as a portion of final landscaping.

3.03 Rough Grading

A. Excavate and fill subgrade material to elevations indicated on plans.

B. Remove topsoil from areas to be further excavated, without mixing with foreign materials.

C. Do not remove topsoil when wet.

D. Remove subsoil from areas to be further excavated.

E. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

F. When excavating through roots, perform work by hand and cut roots with sharp axe.

G. See Section 31 2323 for filling procedures.

H. Benching Slopes: Horizontally bench slopes greater than 4:1 to key fill material to slope for firm bearing.

I. Replace displaced subgrade in accordance with Section 31 2323.

J. Remove and replace unsuitable materials as specified fill.

3.04 Fine Grading

A. Scrape and spread subgrade material uniformly smooth and without disruptions as indicated on drawings.

3.05 SOIL REMOVAL

A. Stockpile topsoil to be re-used on site; remove remainder from site.

B. Stockpile subsoil to be re-used on site; remove remainder from site.

C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.06 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1-1/2 inch in size. Remove soil contaminated with petroleum products.

C. Where topsoil is to be placed, scarify surface to depth of 3 inches.

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

E. Place topsoil in areas indicated on drawings.

F. If not otherwise indicated, place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: 4 inches.
   2. Areas to be Sodded: 4 inches.

G. Place topsoil during dry weather.

H. Remove roots, weeds, rocks, and foreign material while spreading.

I. Near plants, buildings, and curbs spread topsoil manually to prevent damage.

J. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

K. Lightly compact placed topsoil.

L. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.07 Tolerances

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

B. Top Surface: Plus or minus 1/2 inch.

3.08 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Engineer as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.09 FIELD QUALITY CONTROL

A. See Section 31 2323 for compaction density testing.

3.10 Cleaning

A. Remove unused stockpiled subsoil. Grade stockpile area to prevent standing water.

C. Leave site clean and raked, ready to receive work.

END OF SECTION

EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for site grading, paving, structures.

B. Trenching for utilities from 5 feet outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Section 01 5713 - Temporary Erosion and Sediment Control.

B. Section 31 2200 - Grading.

C. Section 31 2323 - Fill.

D. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. Excavating Soil Materials:

1. Measurement method: By the cubic yard measured before removal.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Verify that existing topography is as shown in the plans. Coordinate with the engineer for any discrepancies prior to start of excavation.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Excavate and backfill, in advance of construction, test pits to determine conditions or location of existing utilities.

C. Locate, identify, and protect utilities that remain and protect from damage.

D. Notify utility company to remove and relocate utilities.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, and existing utilities from excavating equipment and vehicular traffic. Repair damage at no additional charge to Owner, including utility company charges.

F. Protect plants, lawns, rock outcroppings, and other features to remain.

G. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Engineer.

3.03 EXCAVATING

A. Excavate to accommodate construction operations and to lines and grades indicated on the drawings.

B. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Excavate to provide adequate work space and clearance for concrete forms. Do not undercut excavation face for extended footings.

D. Steep slope and trench excavations shall conform with OHSA standards for shoring and safety protection.

E. Do not interfere with 45 degree bearing splay of foundations.

F. Cut utility trenches wide enough to allow inspection of installed utilities.

G. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume.

H. Provide temporary means and methods, as required, to remove all water from excavations until directed by Engineer. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

I. Stockpile excavated material to be re-used in area designated on site.

J. Remove excess excavated material from site. Transport and place in accordance with all applicable regulations. Do not dispose of excess material in any stream or watercourse. Do not dump excess material on public property. Do not dispose of excess material on private property unless authorized by Owner.

K. Structure and Roadway Excavations:
   1. Subgrade shall be firm, dense, and compacted to 95 percent maximum density at a moisture content between optimum and optimum plus or minus 4 percent unless otherwise indicated in the Project Geotechnical Report.
   2. Bottom of excavations for footings and slabs shall be level, clean, dry, and clear of loose material.
   3. Remove unsuitable material and replace with suitable material as required or directed by Testing Laboratory.
   4. Refill over-excavated areas with properly compacted select backfill material.
   5. Extend excavation 5 feet minimum on each side of structure or footing unless otherwise indicated on drawings.
   6. Proof roll exposed design subgrade using a 25 ton pneumatic tire roller, maintaining a minimum tire pressure of 75 psi. Proof rolling operation shall be inspected by Testing Laboratory. Any soft or unconsolidated zones or areas detected by proof rolling operations shall be undercut as directed by the Engineer or the Testing Laboratory. Undercut subgrade shall be scarified to a minimum depth of six inches and compacted to a minimum of 95 percent maximum density at a moisture content between optimum and optimum plus 4 percent unless otherwise indicated in the Project Geotechnical Report. After the undercut subgrade has been scarified and compacted, the undercut shall be backfilled with select backfill to the design subgrade elevation. The final subgrade shall be reviewed by the Engineer or the Testing Laboratory.
   7. The surface of the subgrade for street excavations shall be finished to the lines and grades as established, and be in conformity with the typical sections shown on the plans. Any deviation in excess of one-half inch in cross section, and in a length of sixteen feet, measured longitudinally, shall be corrected by loosening, adding, or removing material, reshaping and compacting by sprinkling and rolling.

3.04 FIELD QUALITY CONTROL

A. Provide for visual inspection of load-bearing excavated surfaces by Engineer before placement of foundations.

3.05 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and exposed soil against physical disturbance, rain, and freeze.

E. Keep excavations free of standing water and completely free of water during concrete placement.

F. Protect footing excavations; construct concrete footings same day excavation is made wherever possible.

END OF SECTION

ROCK REMOVAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of rock during excavation.

1.02 RELATED REQUIREMENTS

A. Section 01 5713 - Temporary Erosion and Sediment Control.

B. Section 31 2316 - Excavation.

C. Section 31 2323 - Fill.

D. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. Rock Removal: By the cubic yard measured before removal. Includes preparation of rock for removal, mechanical disintegration of rock, removal from position, loading and removing from site. For over excavation, payment will not be made for over excavated work nor for replacement materials.

B. Trench Rock Removal: By the cubic yard measured before removal. Includes preparation of rock for removal, mechanical disintegration of rock, removal from position, loading and removing from site. For over excavation, payment will not be made for over excavated work nor for replacement materials.

1.04 DEFINITIONS

A. Rock: Solid mineral material of a size that cannot be removed with a 3/4 cubic yard capacity loader bucket.

1.05 REFERENCE STANDARDS -- NOT USED

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.03 USE OF EXPLOSIVES -- NOT USED

3.04 ROCK REMOVAL

A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.

B. Form level bearing at bottom of excavations.

C. Remove shaled layers to provide sound and unshattered base for footings or site structures.

D. Correct unauthorized rock removal to directions of Engineer.

E. Vertical rock faces assumed to be competent rock as indicated on drawings shall be excavated by milling machine or rock saw. "Hoe ramming" or "ripping" will not be allowed. Unstable vertical rock faces caused by improper rock excavation methods shall be stabilized using

structural retaining materials acceptable to Owner and Engineer at no additional charge to Owner.

F. Coordinate with Owner and Engineer for stockpiling of boulders larger than 3 feet for landscape features.

G. If onsite excavated material is to be used as onsite fill, refer to Geotechnical Report and Section 31 2323 - Fill for requirements.

H. Control noise and dust from on-site rock crushing and screening operations. Comply with all applicable regulations.

I. Onsite rock crushing facilities are subject to all Local, State, and Federal codes and permits. The contractor shall obtain all necessary permits for rock crushing facilities at no additional expense to the owner.

J. If excavation encounters a geologic feature, reference Section 02 5100.

END OF SECTION

FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for building volume below grade, footings, slabs-on-grade, paving, and utilities within the building.

B. Filling holes, pits, and excavations.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 - Grading.

B. Section 31 2316 - Excavation.

C. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. General Fill:
   1. Measurement Method: By the cubic yard.
   2. Includes: Excavating existing soil, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

B. Structural Fill:
   1. Measurement Method: By the cubic yard.
   2. Includes: Excavating existing soil, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

C. Granular Fill:
   1. Measurement Method: By the cubic yard.
   2. Includes: Excavating existing material, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

D. Aggregates:
   1. Measurement Method: By the cubic yard.
   2. Includes: Excavating existing material, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

1.04 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: Indicated on drawings.

1.05 REFERENCE STANDARDS

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; 2010.

B. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2014.

C. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

D. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

E. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

F. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

G. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

H. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

I. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

J. TxDOT TEX-113-E, Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials, using 5.5 lb rammer and 12-inch drop.

1.06 SUBMITTALS

A. Samples: sample of each type of fill; submit each material sample in three 5-gallon air-tight containers to testing laboratory.

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

D. Compaction Density Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where designated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill: Subsoil excavated onsite, imported borrow.
   1. For imported borrow, gradation less than 15 percent passing No. 200 sieve as determined by ASTM D 1140.
   2. For imported borrow, plasticity index less than 20 percent as determined by ASTM D 4318.
   3. No vegetative matter or debris.
   4. No rocks larger than half of the lift thickness.

B. Structural Fill:
   1. Refer to Geotechnical Engineering Report.
   2. If a Geotechnical Engineering Report is not available then comply with TxDOT Item 247 Type A Grade 2 Base.
   3. Graded in accordance with the following limits unless otherwise indicated:
      a. 1-3/4 inch sieve: 90-100 percent passing.
      b. No. 4 sieve: 25-55 percent passing.

c. No. 40 sieve: 15-40 percent passing.

4. Mixture shall be crushed stone and contain no clay lumps or organic matter.
5. Fraction passing No. 40 sieve shall have a liquid limit less than 40 and a plasticity index less than 12 as determined by ASTM D 4318.

C. Granular Fill : Crushed limestone or pea gravel ; free of shale, clay, friable material and debris.
1. Graded in accordance with ASTM C136/C136M, within the following limits:
a. 1/2 inch sieve: 95 percent passing.
b. No. 4 sieve: 5 percent passing.

D. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.
1. Graded in accordance with ASTM C136/C136M; within the following limits:
a. No. 4 sieve: 100 percent passing.
b. No. 200 sieve: 0 to 10 percent passing.

E. Drain Gravel: Washed gravel.
1. Material shall have an LA abrasion number of 35 or less.
2. Graded within the following limits:
a. 2 inch sieve: 100 percent passing.
b. 1-1/2 inch sieve: 90-100 percent passing.
c. 1 inch sieve: 25-55 percent passing.
d. 1/2 inch sieve: 0-10 percent passing.
e. 1/4 inch sieve: 0-5 percent passing.

2.02 SOURCE QUALITY CONTROL

A. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

B. If tests indicate materials do not meet specified requirements, change material and retest.

C. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Verify that existing topography is as shown in the plans. Coordinate with the engineer for any discrepancies prior to start of excavation.

C. Identify required lines, levels, contours, and datum locations.

D. See Section 31 2200 for additional requirements.

E. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

F. Verify structural ability of unsupported walls to support imposed loads by the fill.

G. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

E. Record locations of underground utilities.

F. If required, remove concrete formwork.

G. Remove trash and debris.

3.03 FILLING

A. Fill to contours and elevations indicated using suitable materials.

B. All select backfill, backfill and fill required for structures and trenches and required to provide the finished grades shown and as described herein shall be furnished, placed and compacted by the Contractor.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Slope grade away from building minimum 2 percent, unless noted otherwise. Make gradual grade changes. Blend slope to transition at grade changes.

G. Correct areas that are over-excavated.

H. All material shall be placed in horizontal loose lifts not exceeding eight inches (8") in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each lift shall be compacted by not less than two complete coverages of the specified compactor. Select backfill shall be placed to the underside of all concrete slabs or paved areas. The fill material shall extend a minimum of five feet (5') outside the face of each structure and be twelve inches (12") below finished grade. The maximum slope of select backfill to the subgrade shall be one vertical to one and one half horizontal.

I. Backfill around and outside of structures and over select backfill shall be deposited in layers not to exceed eight inches (8") in uncompacted thickness and mechanically compacted, using platform type tampers. Compaction of structural backfill, by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of select backfill and/or backfill by inundation with water will not be permitted. All materials shall be deposited as specified herein and as shown on the drawings.

J. Unless otherwise indicated in the Geotechnical Report, all material shall be placed at a moisture content that falls in the range of laboratory optimum moisture content and laboratory optimum +4%. It shall be compacted to a density of 95 percent (95%) of the maximum laboratory dry density for that material as determined by TxDOT TEX-113-E. The Contractor shall provide equipment capable of adding measured amounts of water to the material to bring it to a condition within the range of the required moisture content. The Contractor shall provide equipment capable of discing, aerating, and mixing the soil to insure reasonable uniformity of moisture content throughout the material and to reduce the moisture content of the material by air drying if necessary. If the subgrade material must be moisture conditioned before compaction, the material shall be sufficiently mixed or worked on the subgrade to insure a uniform moisture content throughout the lift of material to be

compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.

K. No material shall be placed when free water is standing on the surface of the area where the material is to be placed. No compaction of material will be permitted with free water on any portion of the material to be compacted. No material shall be placed or compacted in a frozen condition or on top of frozen material. Any material containing organic materials or other unacceptable material previously described shall be removed and replaced with acceptable material prior to compaction.

L. Each lift of compacted material shall be compacted by the designated number of coverages of all portions of the surface of each lift by a smooth drum vibratory roller for granular material having a static weight not less than 5,500 pounds, a sheepsfoot roller for cohesive material exerting a pressure of 250 psi on the surface of the feet, or equivalent equipment, prior to commencement of the work. One coverage is defined as the condition obtained when all portions of the surface of the backfill material have been subjected to the direct contact of the compactor. The compactor shall be operated at a forward speed not exceeding 40 feet per minute.

M. Compaction shall be performed with equipment suitable for the type of material being placed. The contractor shall select equipment which is capable of providing the minimum density required by these Specifications. The gross weight of compacting equipment shall not exceed 7,000 pounds within a distance of ten feet (10') from the wall of any existing structure or completed structure under this contract. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping. The effectiveness of the equipment selected by the Contractor shall be tested at the commencement of compacted material work by construction of a small section of material within the area where material is to be placed. If tests on this section of backfill show that the specified compaction is not obtained, the Contractor shall increase the amount of coverages, decrease the lift thicknesses or obtain a different type of compactor.

N. Particular care shall be taken to compact structure backfill which will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to an elevation twelve inches (12") above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

O. The compaction requirements specified are predicated on the use of normal materials and compaction equipment. In order to establish criteria for the placement of a controlled fill so that it will have compressibility and strength characteristics compatible with the proposed structural loadings, a series of laboratory compaction and/or compressive strength tests will be performed on the samples of materials submitted by the Contractor. From the results of the laboratory tests, the final values of the required percent compaction, the allowable compaction moisture content range, and the maximum permissible lift thickness will be established for the fill material and construction equipment proposed.

P. Compaction Density, unless otherwise specified or indicated:
   1. Standard: TxDOT TEX-113-E.
   2. Required Density: 95 percent of the maximum dry density.
   3. Lift Thickness: 8 inches.
   4. Moisture Content: Between optimum and optimum +4 percent.

5. Testing laboratory will perform density tests at completion of each lift.
6. If the tests indicate unsatisfactory compaction, the Contractor shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed by the Contractor at no additional cost to the Owner until the specified compaction is obtained. This work shall include complete removal of unacceptable (as determined by the Testing Laboratory) fill areas and replacement and recompaction until acceptable fill is provided.
7. Pit Run Sand Placement: Pit run sand shall be placed and compacted to the limits shown on the drawings.
8. Drainage Gravel: Drain gravel shall be compacted in maximum 8-inch lifts with a minimum of two passes of a hand operated vibratory plate compactor weighing between 150 and 500 pounds.

Q. Reshape and re-compact fills subjected to vehicular traffic.

R. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 FILL AT SPECIFIC LOCATIONS

3.05 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

3.06 FIELD QUALITY CONTROL

A. Refer to the Geotechnical Engineer for general requirements for field inspections and testing.

3.07 CLEANING

A. Leave unused materials in a neat, compact stockpile.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 40 05 01 – PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general duty valves for process piping systems. Special purpose valves not identified within are specified in individual Division 33 and/or Division 40 Specification Sections. Valve selection shall comply with the latest GBRA standards as outlined in the GBRA Developer's Resource Guide, the GBRA Standards and Design Guidelines for Wastewater Treatment Plants and Lift Stations and the GBRA Standards and Design Guidelines for Developer Utilities.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensional data, weights, service type (burial, submerged, etc.) lubrication, required clearances and installation instructions.

C. Furnish list of compliance standards (i.e. AWWA, ASTM, ANSI, etc.) met by valve design.

D. Manufacturer shall perform tests as described in AWWA Standards (standard dependent on valve type) and submit certified test results demonstrating compliance.

E. Provide electrical wiring diagrams for power & control or air instrumentation diagram for pneumatically actuated valves, as applicable.

1.4 QUALITY ASSURANCE

A. Comply with the requirements specified in Division 1.

B. American Water Works Association (AWWA).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation For Transport: Prepare valves for shipping as follows:
   1. Ensure valves are dry and internally protected against rusting and corrosion.
   2. Protect valve ends against damage to threads, flange faces, and weld ends preps.
   3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.

B. Storage: Use the following precautions during storage:
   1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.

C. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gate Valves
   1. Kennedy Valve Mfg. Co.
   2. Mueller Valve
   3. American Flow Control
   4. Watts (3 inch and smaller)

B. Ball Valves
   1. Watts
   2. Nibco
   3. Nibco (PVC valves)
   4. GF (PVC valves)
   5. Hayward (PVC valves)
   6. Spears (PVC valves)
   7. Chemline (for chemical applications)
   8. Hayward (for chemical applications)

C. Butterfly Valves
   1. Keystone
   2. Nibco
   3. Dezurik
   4. Pratt

D. Check Valves

1. Crane
2. Clow Corp
3. G-A Industries
4. Asahi (PVC valves)
5. Chemline (for chemical applications)
6. Hayward (for chemical applications)

E. Plug Valves
1. Crispin
2. GA
3. Milliken
4. Pratt

F. Diaphragm Valves (for chemical applications)
1. Hayward
2. Chemline, or equal

G. Air Release Valves
1. A.R.I Model D-025L

H. Mud Valves
1. Troy
2. Kennedy
3. Clow

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or non-rising stems
1. Rising stem valves shall not be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As required to suit system pressures and temperatures.

C. Sizes: Same sizes as upstream pipe, unless otherwise indicated.

D. Extended Stems: where insulation is indicated or specified, provide extended stems arranged to allow access to valve handles.

E. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

F. End Connections: As indicated in the valve specifications.
1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.

2.3 GATE VALVES

A. Valves shall be iron body resilient seated valves complying with AWWA C-509. Unless

otherwise noted on the plans, they shall be non-rising stem, flanged ends with stainless steel bolts and nuts.

B. O-ring stem seal shall turn left-handed to open with handwheel operators.

C. Shall be provided with handwheel operators for above ground service and square nut operators for buried service unless otherwise noted.

2.4 BALL VALVES

A. Metal Ball Valves shall be rated for 150 psi, 600 psi WOG pressure; two-piece construction, with bronze body conforming to ASTM B 62, standard (or regular) port, chrome-plated brass ball (provide stainless steel where noted), replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl- covered steel handle.

B. PVC Ball Valves: Shall be schedule 80 PVC or CPVC construction, rated for 235 psi (up to 4") and 150 psi minimum working pressure (above 4"). Shall have EPDM seals. Provide Asahi, GF, Hayward or Spears True Union Industrial Ball Valves, or equal.

2.5 BUTTERFLY VALVES

A. Butterfly Valves shall conform to AWWA C519, rated at 150 psi; cast iron body conforming to ASTM A 126, Class B.
B. Provide valves with bonded EPDM seat, nickel-plated ductile iron disc, stainless steel stem, and EPDM O-ring stem seals. Provide lever operators with locks for sizes 2 through 6 inches and gear operators with position indicator for sizes 8 through 24 inches. Provide lug or flange type as indicated.

2.6 CHECK VALVES

A. Swing Check Valves shall conform in all respects to AWWA C508. All valves shall have flanges conforming to ANSI B16.1, Class 125. All swing-check valves are to be equipped with an outside lever and weight assembly. Shall be suitable for mounting in horizontal or vertical orientation (refer to drawings). Where outside lever and weight assemblies are not adequate to provide sufficient back-pressure or closing pressure, an outside spring actuated lever arm shall be provided.

B. Body, cover, disc, and levers shall be cast iron. Seat shall be stainless steel and renewable seating ring shall be Buna-N. Pivot shaft shall be stainless steel. Fasteners holding seating ring in place shall be stainless steel.

C. Where cushion cylinder is specified, it shall be bronze and pivot shaft shall be sealed off from the cushion cylinder through a stuffing box. Check valve shall be independently adjustable for disc closing speed and for range over which cushion cylinder operates.

D. Check valves with limit switch: Limit switch and check valve shall be provided by single supplier with switch factory mounted, adjusted, and tested prior to delivery to project site. Switch shall be rated for 120 VAC, shall be UL listed assembly, plunger actuated and DPDT double break. Switch

mounting bracket and hardware shall be stainless steel.

2.7 PLUG VALVES-SLUDGE AND WASTEWATER APPLICATIONS

A. All plug valve shall be of the tight-closing, resilient-faced plug type and shall be of bi-directional eccentric seating such that the opening movement of the closing member results in the closing member rising off the body seat contact.

B. Valves shall be drop tight at rated pressure of 175 psi (3”-12”) and 150 psi (14”-24”). Valves shall be appropriate for applications involving frequent operation, throttling service and for applications involving open/closed operation.

C. Valve bodies shall be constructed of cast iron ASTM A-126 Class B. Flanges shall be faced and drilled in accordance with ANSI B16.1, Class 125. Mechanical joint end bodies shall be in full compliance with ANSI A21.11.

D. Plug valves 6” and larger shall be equipped with gear actuators and handwheels. Smaller than 6” shall be equipped with square operating nuts and one wrench for every valve.

E. Valves installed higher than 6 feet from finish floor shall be installed with chainwheel actuators.

2.8 VALVES – CHEMICAL APPLICATION

A. Diaphragm valves: Shall be suitable for modulating and ON/OFF service. Shall include diaphragm travel stop, position indication, union type connections, and viton diaphragms, unless otherwise noted. Shall be of CPVC construction.

B. Check Valves: Shall be ball check type and suitable for mounting horizontal or vertical. Shall be of CPVC construction with Viton seals, unless otherwise noted. Shall be true union ball check valves.

C. Ball Valves: Shall be of CPVC construction. Shall be rated for 150 psi minimum working pressure. Shall have Viton seals with Teflon PTFE ball seats. Ball valves in chemical applications where off-gassing may occur (i.e. Sodium Hypochlorite applications) shall be vented or shall be provided with a modified ball on one side to allow pressure release.

2.9 AIR RELEASE VALVES

A. Shall be as indicated on the drawings or as specified below.

B. Shall be Model D-025L with a reinforced nylon body and a stainless steel body clamp.

C. The valve shall allow the steady release of air and seal tight, without leakage.

D. Connection type and size shall be as shown on the plans.

2.10 WASTEWATER AIR RELEASE VALVES

A. Shall be as indicated on the drawings or as specified below.

B. Shall be Model D-025L with a reinforced nylon body and a stainless steel body clamp.

C. Shall be float operated, suitable for wastewater service up to 150 psi.

D. The valve shall allow the steady release of air and seal tight, without leakage.

E. Connection type and size shall be as shown on the plans.

2.11 MUD VALVES

A. Valves shall be cast iron (ASTM A126, class B) body, frame, plug, and yoke with zinc-plated bolts and nuts. Operating stem, lift nut, and seat ring shall be bronze (B421).

B. Plug seat shall be seamless molded, tapered resilient ring (BUNA-N)

C. Shall turn left to open with rising stem (unless otherwise noted). Shall be provided withstainless steel extension stem and stem guides with cast iron handwheel operator.

D. Drip tight shut-off against a minimum of 15 feet of seated or unseated head.

E. Provide two-part epoxy coating per Specification Section 09900.

2.12 FLAP VALVES

A. The flap valve shall have a cast iron body and cover.

B. The seat and disc ring shall be bronze, and the hinge pin and cotter pins shall be stainless steel.

C. The valve shall be constructed with a 10-degree offset from vertical to ensure positive closure.

D. The flange shall be ANSI B16.1, Class 125.

E. All iron parts shall be coated in TNEMEC 2-part epoxy with 3-4 mils dry film thickness to prevent rusting or corrosion.

F. The manufacturer shall show proof of ISO 9001 certification.

G. Valve and accessories shall be: manufactured by Troy Valve, Model A2540 or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.

B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.

C. Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.

D. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

F. Replace defective valves with new valves.

3.2 VALVE END SELECTION

A. Select valves with ends as shown on drawings.

3.3 VALVE INSTALLATIONS

A. General Application: Unless noted otherwise, use gate, ball, plug, and butterfly valves for shut-off duty; use plug valves for throttling wastewater and butterfly valves for throttling air.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves to allow equipment removal and disassembly of piping without system shut down. Unions or dismantling joints shall be required where necessary.

D. Install valves in horizontal piping with stem at or above the center of the pipe, unless otherwise shown.

E. Install valves in a position to allow full stem movement.

F. Installation of Check Valves: Install for proper direction of flow as follows, unless otherwise noted:
   1. Swing Check Valves: Horizontal position with hinge pin level.

G. Valves shall be factory painted. Field painting or touch-up painting shall be as specified in Section 09 09 00.

3.4 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.

B. Apply appropriate tape or thread compound to the external pipe threads.

C. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

A. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly.

3.6 AIR RELEASE/SEWAGE AIR RELEASE VALVE INSTALLATION

A. The air release valves shall be installed at the locations on the drawings. Pipe taps, joints and fittings shall be made up as described in the appropriate individual specification sections or as necessary to provide a complete and working installation.

B. All air release valves shall be installed with an isolation valve unless otherwise noted.

C. Valves shall be installed per the manufacturer's recommendations, valves leaking fluids shall be repaired or replaced as determined by the Engineer.

3.7 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valves if leaks persist.

3.8 ADJUSTING AND CLEANING

A. Cleaning: Clean exterior of valves and prepare valves to receive finish painting or insulation as indicated in the drawings.

B. Contractor shall field test each valve upon completion of piping systems to verify valves are properly adjusted and sealing leak-tight.

END OF SECTION 40 05 00

SECTION 40 05 07 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Structural attachments.
   4. Pipe guides.
   5. Formed steel channel.

1.2 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM A36 - Standard Specification for Carbon Structural Steel.
   2. ASTM A36M - Standard Specification for Carbon Structural Steel. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
   3. ASTM A47M - Standard Specification for Ferritic Malleable Iron Castings. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   4. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   5. ASTM A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

B. American Welding Society:
   1. AWS D1.1 - Structural Welding Code Steel - Reference Manual.
   2. AWS D1.6 – Structural Welding Code – Stainless Steel – Reference Manual.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacturer, Selection, Application, and Installation.
   2. MSS SP-90 – Guidelines on Terminology for Pipe Hangers and Supports

1.3 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog data including load capacity.

C. Shop Drawings: Indicate system layout with location - including critical dimensions, sizes, and pipe hanger and support locations - and detail of trapeze hangers, anchors, and guides.

D. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX or AWS D1.1, D1.6 as appropriate to the work, verifying qualification within previous 12 months.

E. Delegated Design Submittals:
   1. Submit calculations sealed by a registered professional engineer.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWS D1.1 and AWS D1.6 for welding hanger and support attachments to building or structure.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.8 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. B-Line Systems Inc., a division of Cooper Industries

2. Empire Industries, Inc.
3. Grinnel Corp
4. PHS Industries, Inc.
5. Anvil International
6. Engineer Approved Equal

B. Description:
1. Pipe Sizes 1 inch and larger: 316 stainless steel, adjustable, clevis.
2. Multiple or Trapeze Hangers: 316 Stainless steel channels with strut clamps, spacers and hanger rods.
3. Wall Support for Pipe Sizes 3 inch and Smaller: 316 stainless steel channel with strut clamps.
4. Wall Support for Pipe Sizes 4 inch through 8 inch: Welded medium duty stainless steel bracket.
5. Vertical Support: Riser clamp. For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500)
6. Floor Supports: 316 Stainless steel adjustable pipe stanchion. Supports shall be saddle or flange mount type.
7. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
   a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling,
   b. Top-beam C-Clamps (MSS Type 19): for use under roof installations with bar-joist construction to attach to top flange of structural shape
   c. Side-beam or Channel Clamps (MSS Type 20): For attaching to to bottom flange of beams, channels, or angles
   d. Center-beam clamps (MSS Type 21): For attaching to center of bottom of flange of beams
   e. Welded beam attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large
   f. C-Clamps (MSS Type 23): For structural shapes
   g. Top-beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge
   h. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams
   i. Steel-Beam Clamps with eye nuts (MSS (type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions
   j. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel
   k. Welded-steel brackets: Use one of the following for indicated loads:
      1) Light (MSS Type 31): 750 lb (340 kg)
      2) Medium (MSS Type 32):1500 lb (680 kg)
      3) Heavy (MSS Type 33): 3000 lb (1360 kg)
8. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system sections

C. Performance and Design Criteria:
1. Pipe Hangers:
   a. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
   b. Provide linkage to permit lateral or axial movement where anticipated.
   c. Where horizontal pipe movement is greater than 1/2 in, or where hanger rod deflection

from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.

2. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
3. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
4. Point Loads:
   a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.
   b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.

5. Noise Reduction: Wrap copper tubes located within buildings with a 2-in-wide strip of rubber at each pipe support, bracket, clip, or hanger.
6. Galvanized, Metallic Coatings: Hot dipped

2.2 HANGER RODS

A. Hanger Rods:
   1. Threaded both ends or all-thread.
   2. Diameter: as indicated on the drawings.

2.3 STRUCTURAL ATTACHMENTS

A. Manufacturers:
   1. B-Line Systems Inc, a division of Cooper Industries
   2. Power-Strut, Div. Tyco International LTD
   3. Grinnel Mechanical Products
   4. Unistrut
   5. Description:
      a. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
      b. Size inserts to suit threaded hanger rods.

B. Mounting Brackets: ASTM A36, welded hot dipped galvanized steel or 316 stainless steel as indicated on the drawings.

C. Beam Clamps:
   1. Manufacturers:
      a. B-Line
      b. Grinnell Mechanical Products
      c. FM Stainless Fasteners
   2. ASTM A36, steel or ASTM A181, forged steel, or 316 stainless steel where indicated on the drawings.
   3. Clamp Size: Based on load to be supported and load configuration.
   4. Anchoring: Locknuts and cup-point set screws.
   5. Reversible top or bottom flange.

D. Riser Clamps:
   1. Manufacturers:
      a. B-Line

b. Grinnell Mechanical Products
2. ASTM A36, steel.
3. Support of Copper Tubing: Provide rubber cushioned clamps.

E. Offset Clamps:
1. Manufacturers:
a. B-Line
b. ITT Grinnell
c. FM Stainless Fasteners
2. Double leg, two-piece.

F. Coatings: Hot dipped galvanization or bare stainless steel.

G. Materials:
1. Within wastewater collection systems, wet wells, headworks areas, process basins and corrosive environments all supports for piping and valves shall be 316 stainless steel.
2. Pipe supports in non-corrosive areas shall be hot dipped galvanized.

2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturer:
a. Simpson Strong-Tie
b. Hilti, Inc,
c. Dewalt

2.5 PIPE GUIDES

A. Intermediate Guides where shown on drawings shall be:
1. Pipes 6 in and Smaller: Pipe clamp with oversize pipe sleeve.
2. Pipes 8 in and Larger: U-bolts with double nuts.

2.6 FORMED STEEL CHANNEL

A. Manufacturers:
1. B-Line.
2. Unistrut
3. Kumar

B. Description:
1. 316 Stainless steel or Hot Dipped galvanized, 12-gage-thick.
2. Slotted holes 2 inch o.c.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not drill or cut structural members.

B. Pipe Hangers and Supports:
   1. Comply MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
   2. Install according to: ASME B31.1, ASME B31.5, ASME 31.9, or MSS SP 58.
   3. Support horizontal piping as indicated on Drawings or as indicated on Shop Drawings.
   4. Place hangers or supports within 12 inch of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment.
   6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
   7. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
   8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
   9. Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
   10. Support riser piping independently of connected horizontal piping.
   11. Provide cushioned hangers and supports for copper piping.
   12. Design hangers for pipe movement without disengagement of supported pipe.
   13. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
   14. Use beam clamps where piping is to be suspended from building or steel.
   15. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
   16. Use offset clamps where pipes are indicated as offset from wall surfaces.
   17. Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed are not exceeded
   18. Fastener System Installation:
      a. Install mechanical-expansion and adhesive anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

C. Insulation:
   1. Provide clearance in hangers and from structure and other equipment for installation of insulation.

D. Supporting piping at equipment:
   1. Provide supports for pipes after vibration isolation components.

3.2 ATTACHMENTS

A. Pipe Hanger Spacing:
   1. Pipe Material: ABS.
      a. Maximum Hanger/Support Spacing: 4 feet
      b. Hanger Rod Diameter: 3/8 inch.
   2. Pipe Material: Cast iron.

a. Maximum Hanger/Support Spacing: 5 feet.
b. Hanger Rod Diameter: 1/2 inch.

3. Pipe Material: PVC and CPVC.
   a. Size: 1-1/2 inch and smaller.
   b. Maximum Hanger/Support Spacing: 4 feet.
   c. Hanger Rod Diameter: 3/8 inch.
4. Pipe Material: PVC and CPVC.
   a. Size: 2 inches and larger.
   b. Maximum Hanger/Support Spacing: 5 feet.
   c. Hanger Rod Diameter:1/2 inch.
5. Pipe Material: Copper tube.
   a. Size: 1-1/4 inches and smaller.
   b. Maximum Hanger/Support Spacing: 6 feet.
   c. Hanger Rod Diameter:1/2 inch.
6. Pipe Material: Copper tube.
   a. Size: 1-1/2 inches and larger.
   b. Maximum Hanger/Support Spacing: 10 feet.
   c. Hanger Rod Diameter:1/2 inch.
7. Pipe Material: Stainless Steel.
   a. Size: 3 inches and smaller.
   b. Maximum Hanger/Support Spacing: 12 feet.
   c. Hanger Rod Diameter:1/2 inch.
8. Pipe Material: Stainless Steel.
   a. Size: 4 inches and larger.
   b. Maximum Hanger/Support Spacing: 12 feet.
   c. Hanger Rod Diameter:5/8 inch.
9. Pipe Material: Ductile Iron
   a. Size: 4 inch and larger.
   b. Maximum Hanger/Support spacing: 10 feet.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1 inch maximum.

END OF SECTION 40 05 07

SECTION 40 05 53 – IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Pipe markers.
   4. Labels.

B. Related Specifications:
   1. Section 01 33 00 Submittal Procedures
   2. Section 09 90 00 - Painting and Coating
   3. Section 46 07 53 – Package MBR System

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
   1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's catalog literature for each product required.

B. Shop Drawings: Submit list of wording, letter size, and color-coding for mechanical identification

1.4 QUALITY ASSURANCE

A. Conform to TCEQ 30 TAC Chapter 217.329 for color scheme for identification of piping systems and accessories.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum one year experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Brady ID

2. Craftmark Pipe Marker
3. Kolbi Pipe Marker Co.
4. Marking Services, Inc.
5. Pipemarker.com
6. Seton Identification Products

B. Description: Laminated three-layer plastic with engraved black letters on light, contrasting background color.

2.2 TAGS

A. Plastic Tags:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Marker
      c. Kolbi Pipe Marker Co.
      d. Marking Services, Inc.
      e. Pipemarker.com
      f. Seton Identification Products
   2. Description:
      a. Round shaped black phenolic tags with white ¼" block letters.
      b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter.

B. Metal Tags:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Marker
      c. Kolbi Pipe Marker Co.
      d. Marking Services, Inc.
      e. Pipemarker.com
      f. Seton Identification Products
   2. Description:
      a. Brass construction; stamped letters.
      b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter with finished edges.

2.3 PIPE MARKERS

A. Color-Coding and Lettering Size: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Marker
      c. Kolbi Pipe Marker Co.
      d. Seton Identification Products
      e. Substitutions: Specified in Section 01 60 00 - Product Requirements.
   2. Description:
      a. Factory-fabricated, flexible, semirigid plastic.
      b. Preformed to fit around pipe or pipe covering.

c. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Underground Pipe Markers:
1. Manufacturers:
a. Brady ID
b. Craftmark Pipe Marker
c. Kolbi Pipe Marker Co.
d. Marking Services, Inc.
e. Pipemarker.com
f. Seton Identification Products
2. Description:
a. Brightly colored, continuously printed, detectable plastic ribbon tape.
b. Minimum 6 inches wide by 4 mil thick.
c. Manufactured for direct burial service.

2.4 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
1. Material and thickness: Multilayer, multicolor, plastic labels for mechanical engraving 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White
3. Background: Blue
4. Maximum Temperature: Able to withstand temperatures up to 160 deg. F
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch
6. Minimum letter size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches
7. Fasteners: Stainless-steel rivets or self-tapping screws

B. Label Content: Include equipment's Drawing designation or unique equipment number, Manufacturer's name, operating capacity and date of installation.

2.5 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe labels: Precoiled, semi rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-adhesive Pipe labels: Printed Plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering size: At least 1-1/2 inches high

2.6 VALVE TAGS

A. Plastic Valve Tags:
   1. Material and thickness: Multilayer, multicolor, plastic labels for mechanical engraving 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White
   3. Background: Blue
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg. F

B. Label Content: Include valve designation or unique number listed on drawings, type of valve (ball, plug, gate, etc.), number of turns to fully open.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Degrease and clean surfaces of any substances that could impair bond of identification materials.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceiling in finished spaces, machine rooms, accessible maintenance spaces such as shafts, tunnels, and plenums, and exterior exposed locations as follows:
   1. Near each valve and control device
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures
   4. Near major equipment items and other points of origination and termination
   5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Tags:
   1. Install tags using corrosion-resistant chain.
   2. Number tags consecutively by location.

C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe or as outlined on typical pipe details.

D. Identify valves in main and branch piping with tags.

E. Piping:

1. Identify piping, concealed or exposed, with plastic pipe markers.
2. Use tags on piping 3/4-inch diameter and smaller.
3. Identify service, flow direction, and pressure.
4. Install in clear view and align with axis of piping.
5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

F. Ceiling Tacks:

1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 40 05 53

SECTION 40 23 01 – PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes mechanical process piping and associated items as specified under this section and as shown on the drawings, unless otherwise noted. Process piping includes, but is not limited to, wastewater, blower air piping, chemical piping, treated effluent piping and potable water piping.

B. This section includes piping insulation (both interior and exterior). Process piping 4" and smaller shall be heat traced and insulated per GBRA standards and as noted on the drawings. Exposed process piping shall be coated per specifications. (Heat tracing shall be as indicated on the electrical drawings).

C. The Contractor shall provide all necessary adapters and restraints required for the connection of pipe of various types, fittings, and valves. There shall be no extra payment for restraints, and/or adapters required for installation.

D. The Contractor shall refer to other specification sections for supporting and testing of piping systems.

All materials provided shall be new, un-used, and in un-damaged condition. All piping shall be free from any defects or damage from exposure to the elements.

PART 2 - PRODUCTS

2.1 DUCTILE IRON (DI) PIPE AND FITTINGS

A. Ductile iron pipe shall have flanged joints for above ground installations and mechanical joints for buried service, unless otherwise noted.

B. Pipe shall conform to the requirements of AWWA C115, C150 and C151. Flanges shall be ANSI B16.1, Class 125.

C. Exposed, above ground piping shall have flanged joints. Flanged fittings shall conform to the requirements of AWWA C110 and C153.

D. Mechanical joint fittings shall be provided for underground installations and where shown on the drawings. Mechanical joint fittings shall be provided in accordance with AWWA C153.

E. Ductile iron pipe and fittings used for untreated wastewater shall be ceramic epoxy lined. Ductile iron pipe and fittings used for all other service shall have an interior cement mortar lining unless otherwise noted on the drawings. Below grade pipingshall have an exterior asphaltic seal coating in accordance with AWWA C104 unless otherwise noted on the drawings. Above grade piping shall be provided with an exterior primer coating compatible with finish coats per section 09 90 00.

F. All Hardware shall be 316 stainless steel.

2.2 RESTRAINTS

A. Restraining glands shall be provided on all mechanical joint fittings and valves on pressurized or pumped piping systems. Restraining glands shall be by EBAA Iron or Engineer approved equal.

B. Restraints for ductile iron pipe shall be installed where indicated on the contract drawings. Restraining glands for ductile iron fittings shall be EBAA Iron Mega-lug or Engineer approved equal.

C. Restraining glands for PVC piping shall be specifically designed for use on PVC pipe and shall be EBAA Iron Series 2000PV, Series 65MJG00 or Engineer approved equal.

D. Restraints for bell and spigot joints shall be installed where indicated on the contract drawings and shall be EBAA Iron or Engineer approved equal.

2.3 SOLVENT WELDED PVC AND CPVC SCH 40 AND SCH 80 PIPE AND FITTINGS

A. All PVC and CPVC Schedule 40 and Schedule 80 pipe and fittings shall be manufactured from Type I, Grade I Polyvinyl Chloride compound with a cell classification of 12454 (23477 for CVPC) per ASTM D1784 and ASTM D 2665 (ASTM F 437/439 for CPVC).

B. The pipe shall be manufactured in strict compliance with ASTM D1785, consistently meeting or exceeding the quality assurance test requirements of this standard with regard to material, workmanship, burst pressure, flattening and extrusion quality.

C. All pipe shall be shipped, stored and installed in accordance with manufacturer's recommendations, project specifications, contract drawings and district standards.

D. Shall be solvent welded pipe and fittings.

E. Plastic piping for chemical applications (i.e. Sodium Hypochlorite, Citric Acid, Ferric Chloride, etc.) shall be CPVC pipe and fittings; suitable for the chemical application noted. Sodium Hypochlorite resistant cement shall be used in Sodium Hypochlorite applications.

2.4 GASKETED POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Pipe and fittings shall have bell and spigot joints with locked in place flexible elastomeric gaskets.

B. Gasketed PVC pipe for pressure service shall be C900, C905 or IPS Pressure Pipe Class 160 or greater. C900 and C905 shall be DR-14, DR-18 or DR-25 PVC pipe or as indicated on the contract drawings. Fittings shall be restrained ductile iron mechanical joint fittings conforming to AWWA C153 and AWWA C111.

C. Gasketed PVC pipe for gravity drain service shall be SDR-26 PVC pipe and fittings as indicated on the contract drawings. Pipe shall conform to ASTM D-3034 or ASTM F679 standards. Pipe and fittings shall be fabricated from an approved class 12364-C compound conforming to ASTM D1784. Joints shall conform to ASTM, D3212 and F477 standards.

D. All hardware used on piping, pipe fittings and appurtenances shall be made of cold formed high

strength, low-alloy steel (COR-TEN), ASTM A242 or stainless steel as indicated on the drawings.

2.5 STAINLESS STEEL PIPE/FITTINGS

A. Piping larger than 2” shall be welded Sch10 304L stainless steel or Sch5 304 stainless steel sanitary pipe and fittings or as indicated on the contract drawings.

B. Welded Sch10 pipe shall be prefabricated prior to delivery to the site. Prefabricated sections shall be flanged to permit field assembly and shall be in sections small enough to be easily installed with minimal equipment. No field welding shall be allowed.

C. Flange bolts and nuts shall be stainless steel.

D. Flange gaskets shall be 1/8” thick, full-face gaskets made of EPDM.

E. All welds shall be electrochemically passivated by trained personnel prior to delivery to the site.

F. Sch5 stainless steel sanitary pipe and fittings shall be prefabricated and assembled onsite with quick clamp connectors.

G. Piping 2” and smaller shall be threaded Sch 40 304 stainless steel or as indicated on the contract drawings.

H. Care should be taken to protect stainless steel from iron contamination during unloading and installation activities.

2.6 WELDED CARBON STEEL PIPE AND FITTINGS

A. All welded carbon steel pipe and fittings shall be minimum schedule 40 or as shown on the drawings.

B. Pipe and fittings shall conform to ANSI B16.9 and ASTM A-234. Flange adapters for welded piping shall conform to ASTM A105 and ANSI B16.5

C. Pipe shall be clean and free from contaminating particles.

D. Pipe and fittings shall meet standard pressure ratings based on ANSI B31 Code for Pressure Piping.

E. Pipe and fittings shall be coated per section 09 90 00.

2.7 EXPANSION JOINT FITTINGS

A. Unless otherwise noted, expansion joints shall be bellows type and shall have ANSI 125/150 flanged connections and shall be suitable for a minimum operating pressure of 125 psi.

B. Construction shall be: reinforced BUNA-N elastomer material, stainless steel backer rings and single arch.

C. Manufacturer shall have at least five (5) years of experience in manufacture of non-metallic

expansion joints. Expansion joints shall be by Proco, Flexicraft or Engineer approved equal.

D. Expansion joints shall be provided with a minimum of two (2) control rods where indicated on the contract drawings. Control rods shall be provided by the expansion joint manufacturer and be restrained in accordance with manufacturer recommendations.

E. Expansion joints for chemical system piping applications shall be Hypalon, unless otherwise noted and shall be slip-on, single arch, with stainless steel bands. Expansion joints shall be SL-50 series by Red Valve Company, or equal.

2.8 PIPE INSULATION

A. Exposed piping 4 inch and smaller shall be heat traced and insulated with a pre-formed fiber glass pipe insulation, complying with ASTM C547, Class 3 (to 850°F [454°C]), rigid, molded, noncombustible (plain) or limited combustibility (jacketed) pipe insulation. (Heat tracing shall be per section

1. Thermal Conductivity ("k"): 0.23 Btu • in/ (hr • ft2 • °F) at 75°F mean temperature (0.033 W/m•°C at 24°C) per ASTM C518.

2. Maximum Service Temperature: 850°F (454°C)

3. Rated 25/50 per ASTM E84, CAN ULC S102 or NFPA 255.

4. When being used over austenitic stainless steel, product must comply with the requirements ASTM C795.

5. All-Service Vapor-Retarder Jacket (ASJ): A white, kraft paper or poly exterior, reinforced with a glass fiber yarn and bonded to an aluminum foil with self-sealing longitudinal closure laps (SSL) and butt strips.

B. Insulation Jackets:

1. PVC Plastic: Zeston 2000 Series. Fittings shall be one-piece, molded type. Jacketing material shall be gloss white.

2. Aluminum Jacket: 0.016" thick sheet, smooth or embossed finish with longitudinal slip joints and 2" laps. Fittings shall be die-shaped and have factory applied protective interior liner of polyethylene-surlyn or polyethylene-kraft paper.

3. Banding shall be .020 inch thick and .5 inch wide stainless steel with wing seals.

C. Seal all ends and seams with mastic. Childers CP-10, or equal.

D. Insulate piping and fittings as indicated on the drawings. Insulation, vapor barrier, and jacketing shall conform to fittings, valves, and other special piping shapes.

E. Provide 1-1/2" minimum thickness unless otherwise noted on plans.

PART 3 - EXECUTION

3.1 GENERAL

A. Piping systems shall be installed as indicated on the drawings. The exact locations of pipe valves and other appurtenances shown or specified may be relocated only at the approval of the Engineer.

B. Pipe and fittings shall be handled in such a manner that the coating and lining are not damaged during their delivery, storage or installation. Pipe with damaged coatings or linings shall be repaired or replaced by the Contractor at their expense, to the satisfaction of the Engineer.

C. For work at existing facilities: The Owner shall be notified a minimum of two (2) weeks prior to beginning work. The Contractor shall coordinate with the Owner's Representative for any necessary change in operating conditions (e.g. open/closing valves, etc.) with a minimum of two (2) days advance notice. The Contractor shall, at no time, operate or alter any aspect of operations of any existing facilities.

3.2 INSTALLATION

A. Install piping and appurtenances as indicated on Drawings using minimum number of joints, and according to manufacturer's instructions.

B. Provide supports and restraints as required. All piping and fittings shall be solidly braced as necessary to prevent any deflection due to thrust pressure or thermal expansion. Bracing shall be accomplished with the use of cast-in-place concrete pipe supports, steel bracing, or other pipe supports as shown on the drawings or approved by the Engineer.

C. The Contractor shall repair any damage to existing utilities, materials, or equipment already installed, caused during the installation of piping systems at their expense per the Owner of the damaged items.

D. Provide flexible couplings and expansion joints at connections to equipment, and where indicated on Drawings.

E. Install couplings, service saddles, and anchors according to manufacturer's instructions.

F. Apply nickel anti-seize lubricant to the threads of all stainless steel hardware during installation.

END OF SECTION 40 23 40

SECTION 40 23 41 – PIPING SYSTEMS TESTING

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes Test requirements for piping systems.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01 33 00 - Submittal Procedures.
      b. Section 01 40 00 - Quality Requirements.
      c. Section 01 50 00 - Temporary Facilities and Controls.
      d. Section 40 23 40 – Process Piping.

1.2 REFERNCES

A. American Society of Mechanical Engineers (ASME):
   1. B31.3 - Process Piping.

B. Underwriters Laboratories Inc. (UL).

1.3 TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in the specifications covering the various types of piping and are specified in this Section.
   2. Test plumbing piping in accordance with the plumbing code.
   3. When testing with water, the specified test pressure is the pressure at the lowest point of the piping section under test.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
   1. Contractor to provide water for testing, cleaning, and disinfecting.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract.

Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plugs or bulkheads.

E. Unsuccessful tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

1.4 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Schedule and notification of tests:
   1. Notification must be provided to the engineer 24 hours prior to any hydrostatic or pneumatic testing.
   2. Have personnel, materials, and required equipment in place before beginning testing operations.

1.5 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Underground gravity piping, including sanitary sewers, shall be tested before fully backfilling. Contractor may partially backfill piping, leaving fittings exposed during testing operations.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise. Contractor shall implement additional restraints or safety precautions, if needed, to ensure pipe can be tested safely.

D. Backfill and compact trench or provide blocking that prevents pipe movement before testing underground piping.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 – PRODUCTS

2.1 TEST MEDIUM

A. Hydrostatic Test: Water should be used as the test fluid whenever possible. In those systems where water cannot be used, the test fluid may be either the one to be used in the system or the one agreed upon by the Engineer and Contractor.

B. Service Pressure Test: The fluid for which the system is designed shall be used. Chemical systems shall be tested with water.

C. Pneumatic Test: Compressed air shall be used. Other gases may be used when specified or directed by the Engineer. Test pressures shall be 110% of the anticipated maximum operating pressure, but not to exceed 100 psig, and not less than 5 psig at the highest point in the system.

2.2 TEST EQUIPMENT

A. Hydrostatic Test:
   1. Water – Of sufficient volume to reach the required test pressure.
   2. Strainer – On inlet side of the pump to prevent foreign matter from entering the system.
   3. Valves – Shall be provided on the suction and discharge side of the pump.
   4. Relief Valve – Set at a pressure to relieve at 10% above the required test pressure.
   5. Pressure Gauges – 4 ½ inch, Glycerin filled, measurement increments of no more than 2 psig, capable of reaching at least 25 psig over the test pressure.
   6. Pressure gauges and relief valves shall be checked for accuracy before being placed into service.

B. Pneumatic Test:
   1. Contractor to provide air compressor capable of supplying adequate volume and pressure required for test.
   2. Valves shall be installed on the discharge side of the compressor.
   3. Relief valve shall be installed relieve at 10% over test pressure.
   4. Pressure Gauges – 4 ½", Glycerin filled, measurement increments of no more than .5 psig, capable of reaching at least 5 psig over the test pressure.

PART 3 – EXECUTION

3.1 TESTING ALIGMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the alignment and grade of gravity piping prior to backfilling trench.

B. Deflection test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider the test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.2 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.

b. For plastic piping, test for deflection by pulling a mandrel through the pipe section. Mandrel shall be a 9-rod mandrel with a contact length no shorter than the nominal diameter of the pipe and an outer diameter equal to 95% of the inside diameter of the pipe.

2. Provide temporary restraints when needed to prevent movement of piping.
3. Hydrostatically test piping with maximum leakage allowance after backfilling.
4. With the lower end plugged, fill the piping slowly with water while allowing air to escape from high points. Keep piping full of water to the highest point for at least 24 hours:
   a. Examine piping for visible leaks. Consider the examination complete when no visible leaks are observed.
   b. Maintain piping with water or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
   c. After the pipe has been filled, subject piping to the maximum static head for minimum of 4 hours while accurately measuring the volume of water added to maintain the static head:
      - Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
         - For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
         - Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.

3.3 TESTING PRESSURE PIPING

A. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
   6. When test results indicate failure of selected sections, limit tests to piping:
      a. Between valves.
      b. Between a valve and the end of the piping.
      c. Less than 500 feet long.
   7. Test piping for minimum 2 hours for visible leaks test and minimum 4 hours for the pressure test.
   8. Test pressure shall be 125% of expected working pressure. Test pressure shall not exceed the rated maximum working pressure of the pipe, fittings, valves or installed components.

B. Testing procedures:
   1. Fill piping section under test slowly with water while venting air.
      a. Use potable water for all potable waterlines and where noted in the Contract documents.
   2. Before pressurizing for the tests, retain water in piping for a water absorption period of 24 hours.

3. Raise pressure to the specified test pressure and inspect piping visually for leaks.
    a. Consider visible leakage testing complete when no visible leaks are observed.

C. Pressure test:
    1. Leakage allowance is zero for piping systems using flanged, threaded, and welded joints.
    2. Pressure test piping after completion of visible leak test.

3.4 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method.

B. General:
    1. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
    2. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
    3. Test piping for minimum 2 hours for visible leaks test and minimum 4 hours for the pressure test.

C. Visible leaks test:
    1. Subject piping under test to the specified pressure measured at the lowest end.
    2. Fill piping section under test slowly with water while venting air:
        a. Use potable water for all potable waterlines.
    3. Before pressurizing for the tests, retain water in piping for the water absorption period of minimum 24 hours.
    4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test:
    1. Pressure test piping after completion of visible leaks test.
    2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
        a. Successful completion of the leakage test shall have been achieved when the observed pressure drop is less than the allowable amount and no damage to piping and appurtenances has occurred.

END OF SECTION 40 23 41

APPENDIX A

GEOTECHNICAL ENGINEERING STUDY FOR LIFT STATION AND WASTEWATER TREATMENT FACILITY NB WEST NEW BRAUNFELS, TEXAS

RABA KISTNER

a kiwa company

GEOTECHNICAL ENGINEERING STUDY

FOR

LIFT STATION AND WASTEWATER TREATMENT FACILITY
NB WEST
NEW BRAUNFELS, TEXAS

RABA KISTNER
a kiwa company
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1913 Post Road, Suite 645
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Project No. ANA24-027-00
October 17, 2024

Colby Mullins
Land Manager
Chesmar Homes
211 North Loop 1604 East, Suite 179
San Antonio, Texas 78232

RE: Geotechnical Engineering Study
Lift Station and Wastewater Treatment Facility
NB West
New Braunfels, Texas

Dear Mr. Mullins:

RABA KISTNER, Inc. (**RKI**) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with **RKI** Proposal No. PNA24-044-00 dated June 25, 2024. The purpose of this study was to drill borings in the vicinity of the proposed lift station and wastewater treatment facility, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting foundation design and construction recommendations.

The following report contains our design recommendations and considerations based on our current understanding of information provided to us at the time of this study. There may be alternatives for value engineering of the foundation. **RKI** recommends that a meeting be held with the Owner and design team to evaluate if alternatives are available.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER, INC.

Santosh Shrestha, E.I.T.
Graduate Engineer

STATE OF TEXAS
TERRANCE IAN PEREZ
101225
LICENSED
PROFESSIONAL ENGINEER

Ian Perez, P.E.
Vice President

SS/TIP/mmd
Attachments
Copies Submitted: Above (1-electronic)

GEOTECHNICAL ENGINEERING STUDY

For

LIFT STATION AND WASTEWATER TREATMENT FACILITY
NB WEST
NEW BRAUNFELS, TEXAS

Prepared for

CHESMAR HOMES
San Antonio, Texas

Prepared by

RABA KISTNER, INC.
New Braunfels, Texas

PROJECT NO. ANA24-027-00

October 17, 2024

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ATTACHMENTS

The following figures are attached and complete this report:

INTRODUCTION

RABA KISTNER, Inc. (**RKI**) has completed the authorized subsurface exploration and foundation analysis for the proposed lift station and wastewater treatment facility (WWTF) at the NB West development in New Braunfels, Texas, as illustrated in Figure 1. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for foundation design and construction considerations.

PROJECT DESCRIPTION

To be considered in this study is a new wastewater treatment facility (WWTF) and separate lift station at the NB West development in New Braunfels, Texas. The site is located on the westernmost extents of the proposed development just north of the northernmost extent of Oak Creek Drive. There is not a site plan depicting the proposed structures currently available for review; however, on the basis of information provided by the designer, JA Wastewater, LLC via email, we understand that the WWTF will include the following structures:

- Influent lift station about 20 ft deep, consisting of fiberglass reinforced polymer (FRP) or concrete;
- Wastewater plant with slab on grade foundation;
- Controls/operations/electrical building with a slab on grade foundation; and
- Effluent lift station about 15 ft deep, consisting of fiberglass reinforced polymer (FRP) or concrete.

In addition to these structures, another lift station is planned east of the WWTF and is currently planned near the proposed thoroughfare road, south of the currently proposed location of Phase 8 of the development. It is our understanding that the lift station will have a maximum depth of 20 ft and will be constructed of either FRP or concrete.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of central Texas and for the use of Chesmar Homes (Client) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods. The attachments and report text should not be used separately.

The recommendations submitted in this report are based on the data obtained from 5 borings drilled at this site, our understanding of the project information provided to us, and the assumption that site grading will result in only minor changes in the existing topography. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. This is particularly true of this site with respect to the depth of the upper surficial clays and the potential presence of solution cavities and/or voids that may not have been encountered in our test borings. The

nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

If site grading results in elevations that vary significantly from the existing grades (more than plus or minus 1 ft), our office should be informed about these changes. If needed and/or if desired, we will reexamine our analyses and make supplemental recommendations.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 5 borings drilled at the locations shown on the Boring Location Map, Figure 1. These locations are approximate, and distances were measured using a hand-held, recreational-grade GPS locator. The borings were drilled to depths ranging from approximately 30 to 40 ft below the existing ground surface using a truck-mounted drilling rig.

During the drilling operations, split-spoon samples with Standard Penetration Tests (SPT) were collected at the depths annotated on our boring logs. Each sample was visually classified in the laboratory by a member of our Geotechnical Engineering staff. The geotechnical engineering properties of the strata were evaluated by moisture content and Atterberg Limits tests.

The laboratory test results are presented in graphical or numerical form on the boring logs illustrated on Figures 2 through 6. A key to classification terms and symbols used on the logs is presented on Figure 7. The results of the laboratory and field testing are also tabulated on Figure 8 for ease of reference.

Standard Penetration Test results (N-values) are noted as “blows per ft” on the boring logs and on Figure 8. The N-value is the number of blows required to drive a split-spoon sampler 1 ft into soil/weak rock with a falling, 140-lb hammer following 6 inches of seating blows. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal (“ref”) will be noted on the boring logs and on Figure 8.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

GENERAL SITE CONDITIONS

GEOLOGY

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain with the soils/rock (limestone) of the Edwards Group. Edwards limestone is generally considered hard in induration and typically contains harder zones/seams of chert and dolomite. Edwards limestone also

typically contains karstic features in the form of open and/or clay-filled vugs, voids, and/or solution cavities that form as a result of solution movement through fractures in the rock mass.

Key geotechnical engineering considerations for development supported on this formation will be the depth to rock, the expansive nature of the overlying clays, the condition of the rock, and the presence/absence of karstic features.

SEISMIC CONSIDERATIONS

The following information has been summarized for seismic considerations associated with this site per ASCE 7-16 edition.

- Site Class Definition: **Class C**. Based on the soil borings conducted for this investigation and our experience in the area, the upper 100 ft of soil may be characterized as very dense soil and soft rock.
- Risk-Targeted Maximum Considered Earthquake Ground Motion Response Accelerations for the Conterminous United States of 0.2-Second Spectral Response Acceleration (5% Of Critical Damping): **S_s = 0.050g**.
- Risk-Targeted Maximum Considered Earthquake Ground Motion Response Accelerations for the Conterminous United States of 1-Second Spectral Response Acceleration (5% Of Critical Damping): **S_1 = 0.027g**.
- Values of Site Coefficient: **F_a = 1.3**
- Values of Site Coefficient: **F_v = 1.5**
- Where g is the acceleration due to gravity.

The Maximum Considered Earthquake Spectral Response Accelerations are as follows:

- 0.2 sec, adjusted: **S_{ms} = 0.066g**
- 1 sec, adjusted: **S_{m1} = 0.041g**

The Design Spectral Response Acceleration Parameters (SA) are as follows:

- 0.2 sec SA: **S_{DS} = 0.044g**
- 1 sec SA: **S_{D1} = 0.027g**

STRATIGRAPHY

The natural subsurface stratigraphy can generally be described as a thin veneer of highly plastic dark brown clay with limestone fragments overlying tan and gray limestone. In Borings B-3 and B-4, marl overlays the tan and gray limestone. The limestone was encountered at approximate depths ranging from 2.5 ft to 13 ft below the ground surface existing at the time of our study and extends to at least the boring termination depths in all of the borings drilled for this study.

The boring logs should be consulted for more specific stratigraphic information. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. Unless noted on the boring logs, the lines designating the changes between various strata represent approximate

boundaries. The transition between materials may be gradual or may occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by **RKI** in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and times where sampling was conducted. The passage of time may result in changes in conditions, interpreted to exist, at or between the locations where sampling was conducted.

GROUNDWATER

Groundwater was not observed in the borings either during or immediately upon completion of the drilling operations. The borings remained dry during the field exploration phase. However, it is possible for groundwater to exist beneath this site at shallow depths on a transient basis, particularly following periods of precipitation. Fluctuations in groundwater levels occur due to variation in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater level.

FOUNDATION ANALYSIS

KARSTIC FEATURES

The site is located in an area known to have karst topography (i.e. open and/or clay-filled vugs, voids, and/or solution cavities in the bedrock). The potential presence of karst features in the vicinity of the site introduces some element of risk and uncertainty for design, construction and performance of the proposed structures. Depending on the final site grading plan, foundation depth and the top of bedrock, boulders, pinnacles, ledge rock (stringers), or clayed filled solution features may be encountered near or at the required bearing stratum. Considerable variation in the bearing elevation and quantity of rock excavation should be anticipated. Appropriate contingency fees should be allocated for removal of weathered limestone and extending foundations through karstic features.

EXPANSIVE SOIL-RELATED MOVEMENTS

The anticipated ground movements due to swelling of the underlying soils at the site were estimated for slab-on-grade construction using the empirical procedure, Texas Department of Transportation (TxDOT) Tex-124-E, Method for Determining the Potential Vertical Rise (PVR). PVR value of 1 in. or less were estimated for the stratigraphic conditions encountered in our borings. A surcharge load of 1 psi (concrete slab and sand layer), an active zone of 15 ft or to the depth of bedrock, and dry moisture conditions were assumed in estimating the above PVR values.

The TxDOT method of estimating expansive soil-related movements is based on empirical correlations utilizing the measured plasticity indices and assuming typical seasonal fluctuations in moisture content. If desired, other methods of estimating expansive soil-related movements are available, such as estimations based on swell tests and/or soil-suction analyses. However, the performance of these tests and the detailed analysis of expansive soil-related movements were beyond the scope of the current study. It should also be noted that actual movements can exceed the calculated PVR values due to isolated changes in moisture content (such as due to leaks, landscape watering....) or if water seeps into the soils to greater depths than the assumed active zone depth due to deep trenching or excavations.

MITIGATION OF EXPANSIVE SOIL-RELATED MOVEMENTS

Because the estimated PVR values are on the order of the generally accepted 1 in. or less, no mitigation is required to reduce the PVR. Fill utilized to achieve the final grade elevations should be selected and placed in accordance with the *Select Fill* section of this report in order to maintain the estimated existing PVR values.

FOUNDATION RECOMMENDATIONS

SITE GRADING

Site grading plans can result in changes in almost all aspects of foundation recommendations. We have prepared all foundation recommendations based on the existing ground surface, and the stratigraphic conditions encountered at the time of our study. If site grading changes, **RKI** must be retained to review the site grading plans prior to bidding the project for construction. This will enable **RKI** to provide input for any changes in our original recommendations that may be required as a result of site grading operations or other considerations.

WET WELL STRUCTURE

Based on the information provided to us, the proposed wet well structures/lift station will extend approximately 15 to 20 ft below the grade existing at the time of our study. The excavation method for the construction of the wet well was not known at the time of this report. If open cut excavation techniques are utilized, the maximum side slopes shall be in accordance to *Excavations and Temporary Slopes* section of this report.

Allowable Bearing Capacity

Foundations for the wet well bearing in hard limestone at an approximate depth of 15 to 20 feet below the existing ground surface should be designed for a maximum allowable bearing pressure of 18 ksf. The above presented maximum allowable bearing pressure will provide a factor of safety of about 3 with respect to the measured shear strength.

RIGID-ENGINEERED BEAM AND SLAB FOUNDATION

Proposed wastewater plant, controls/operations/electrical buildings or any other ancillary structures, if any, may be founded on a shallow foundation provided the selected foundation type can be designed to withstand the anticipated soil-related movements (see *Expansive Soil-Related Movements*) without impairing either the structural or the operational performance of the structures.

Differential Settlement in Transition Zone

To reduce the potential for differential settlement at soil/fill and rock transitions, the more positive approach for foundation support would be to extend all footings to rock/marl. Alternatively, the footings may bear on a combination of soil/fill and rock if differential movements can be tolerated. With footings on mixed bearing conditions, the client must recognize and accept a greater than normal risk of

differential settlement as hinges may occur at unpredictable locations due to the irregular occurrence of shallow bedrock. Special provisions that should be considered for footings bearing on mixed bearing materials (natural soil/ fill and rock) to reduce the effects of differential settlement include the following:

- Frequent jointing of exterior walls;
- Selection of flexible building veneer materials; and
- Overexcavation of footing subgrades to top of rock and backfilling with compacted crushed rock.

Allowable Bearing Capacity

Shallow Foundation Design Parameters	
Minimum depth below final grade	18 in. (1)
Minimum beam or strip footing width	12 in.
Minimum widened beam or spread footing width	18 in.

(1) If intact bedrock is encountered, minimum foundation depth should be discussed with the structural engineer, but may be reduced to 12 in.

Shallow Foundation Type	Maximum Allowable Bearing Pressure
Grade Beams or strip footings	3,000 psf
Widened beams or spread footings	3,500 psf
Foundations on intact or weathered limestone	4,500 psf (1)

(1) Mixed bearing conditions (i.e. bearing on soil/fill and bedrock) should be avoided to reduce potential for differential settlement.

We do not recommend that the grade beams for an individual structure be founded partially in bedrock and partially in natural soils or compacted fill as this condition may result in greater differential movements. **If mixed bearing conditions are encountered, we recommended that all grade beams either be extended down into the bedrock, or if constructed on a select fill building pad, that a minimum of 1 ft of select fill be placed and compacted beneath the grade beams.**

The above presented maximum allowable bearing pressures will provide a factor of safety of about 3, provided that fill is placed as discussed herein and the subgrade is prepared in accordance with the recommendations outlined in the *Site Preparation* section of this report.

Depending on the structural loads and if higher bearing pressures are requested/desired, rock-bearing shallow foundations proportioned for greater than 4,500 psf bearing pressures may require additional probe borings with pilot holes at actual foundation locations. Alternatively, the requirement for pilot hole or probe holes may be waived if the bearing pressure provided herein is used.

Rock bearing foundations should bear on relatively competent rock, which may underlie a few feet of weathered rock. The foundations should be excavated through the weathered rock to expose competent

rock. Excavation into the limestone will require hard rock excavation techniques. The bottom of the excavation should generally be level; however, it is permissible to excavate vertical steps if required to expose sound bedrock. Loose rock should be removed from all foundation excavations. Overexcavation may be backfilled with lean concrete or flowable fill.

The foundation subgrade should be observed by the Geotechnical Engineer or their representative prior to placement of reinforcing steel and concrete. This is necessary to observe that the bearing materials at the bottom of the excavations are similar to those encountered in our borings, that excessive loose materials, mixed bearing conditions, and water are not present in the excavations. If soft soils are encountered in the foundation excavations, they should be removed and replaced with compacted engineered fill material, flowable fill, or lean concrete up to the design foundation bearing elevations.

Uplift Resistance

Resistance to vertical force (uplift) is provided by the weight of the concrete footing plus the weight of the soil directly above the footing. For this site, it is recommended that the ultimate uplift resistance be based on total unit weights for soil and concrete of 120 pcf and 150 pcf, respectively. The calculated ultimate uplift resistance should be reduced by a factor of safety of 1.2 to calculate the allowable uplift resistance.

Lateral Resistance

Horizontal loads acting on shallow foundations will be resisted by passive earth pressure acting on one side of the footing and by base adhesion for footings in soil or limestone. Resistance to sliding for foundations bearing on natural/compacted soil or limestone should be calculated utilizing an ultimate coefficient of friction of 0.30 or 0.70, respectively. The ultimate resistance for these foundations should be limited to 1,050 psf (soil) or 3,150 psf (rock). An equivalent fluid pressure of 240 pcf (soil) or 350 pcf (rock) should be utilized to determine the ultimate passive resistance, if required.

AREA FLATWORK

It should be noted that ground-supported flatworks such as walkways, courtyards, etc. will be subject to the same magnitude of potential soil-related movements as discussed previously (see *Expansive Soil-Related Movement* section). Thus, where these types of elements abut rigid structure foundations, differential movements should be anticipated. As a minimum, we recommend that flexible joints be provided where such elements abut the main structure to allow for differential movement at these locations. Where the potential for differential movement is objectionable, it may be beneficial to consider methods of reducing anticipated movements such as transitioning the select fill building pad to beneath critical sections of flatwork.

For flatwork supported by 6 inches of compacted crushed rock, a subgrade modulus (k-value) of 150 pci may be utilized for slabs constructed for this project. The subgrade modulus may be increased to 250 pci if the floor slabs and flatwork are underlain by 2 feet or more of compacted aggregate select fill.

DRILLED PIERS

Deep foundations (i.e. drilled, straight-shaft piers) bearing in competent limestone may be considered to support the structure. Consequently, pier capacity may be equal to the summation of the following:

- The end area of the pier multiplied by the allowable end-bearing pressure; and
- The wall area of the pier socket below a depth of 5 ft into the underlying bedrock surface area multiplied by the allowable side shear resistance.

For shafts excavated in limestone with potential karstic features, pilot holes can be drilled at the bottom of the pier excavations to evaluate the presence of voids near the bottom of the shaft. Pilot holes are performed at the time of drilled pier construction and consist of 2-inch diameter holes drilled from the bottom of excavated shafts to a depth equal to two pier diameters below the bottom of each pier.

An allowable end-bearing pressure of 40 ksf may be utilized for piers where pilot holes are performed. This bearing pressure was calculated using a factor of safety of 3. If pilot holes are not performed, then we recommend piers be designed using side friction only. We recommend that drilled, straight-shaft piers extend a minimum of 5 ft into native, intact limestone. An allowable side shear resistance of 3.5 ksf may be utilized for the portion of the shaft extending to a minimum depth of 5 ft or 2 pier shaft diameters, whichever results in the lower elevation, into the native, intact limestone layer. This is based on a factor of safety of 2 with respect to the design shear strength. These values may be increased by 1/3 for transient load conditions.

Side shear should be neglected in fill material, clay layers, voids, and/or clay filled voids. Based on the maximum depth of exploration, piers should be sized such that the pier bottom does not extend deeper than 35 ft without prior review and approval from **RKI** and/or observations of the pier/pilot holes confirm the presence of native, intact limestone the full depth of the pier and below.

Final shaft depths will be based on interpretation of conditions in the field at the time of construction. If clay seams/and or voids are encountered within the limestone formation during drilled shaft excavations, the shafts must be extended by that length to develop the required side shear resistance.

Representatives from **RKI** must be present at the time of construction to verify that conditions are similar to those encountered in our borings and that sufficient penetration into the limestone is achieved. For bid purposes, the owner should anticipate that deeper piers will be required in some areas. Consequently, contractors bidding on the job should include unit costs for various depths of additional pier embedment. Unit costs should include those for both greater and lesser depth in both rock and soil.

Due to the presence of limestone high-powered, high-torque drilling equipment should be anticipated for drilled pier construction at this site (see also Excavation Equipment).

Excavations for grade beams may be performed vertically. In addition, since the grade beams will be excavated in limestone or select fill, carton forms are not required and may bear on the exposed bedrock or select fill.

Pier Shaft Potential Uplift Forces

The pier shafts will be subject to potential uplift forces if the surrounding expansive soils within the active zone are subjected to alternate drying and wetting conditions. The maximum potential uplift force acting on the shaft may be estimated by:

$F_u = 15*D$

where:

F_u = uplift force in kips; and
D = diameter of the shaft in ft.

Allowable Uplift Resistance

Resistance to uplift forces exerted on the drilled, straight-shaft piers will be provided by the sustained compressive axial force (dead load) plus the allowable uplift resistance provided by the bedrock. The allowable uplift resistance provided by the bedrock at this site may be estimated using 2 ksf for that portion of the shaft penetrating the limestone, respectively, and neglecting the upper 5 ft into the native, intact limestone layer.

Reinforcing steel will be required in each pier shaft to withstand a net force equal to the uplift force minus the sustained compressive load carried by that pier. We recommend that each pier be reinforced to withstand this net force.

Pier Spacing

Where possible, we recommend that the piers be spaced at a center-to-center distance of at least three shaft diameters for straight-shaft piers. Such spacing will not require a reduction in the load carrying capacity of the individual piers.

If design and/or construction restraints require that piers be spaced closer than the recommended three pier diameters, RKI must re-evaluate the allowable bearing capacities presented above for the individual piers. Reductions in load carrying capacities may be required depending upon individual loading, spacing conditions and settlement tolerances.

Lateral Resistance

Resistance to lateral loads and the expected pier behavior under the applied loading conditions will depend not only on subsurface conditions, but also on loading conditions, the pier size, and the engineering properties of the pier. As this information is not yet available, analysis of pier behavior is not possible at this time. Once preliminary pier sizes, concrete strength, and reinforcement are known, piers should be analyzed to determine the resulting lateral deflection, maximum bending moment, and ultimate bending moment. This type of analysis is typically performed utilizing a computer analysis program and usually requires a trial-and-error procedure to appropriately size the piers and meet project tolerances.

To assist the design engineer in this procedure, we are providing the following soil parameters for use in analysis. These parameters are in accordance with the input requirements of one of the more commonly used computer programs for laterally loaded piles, the LPile program. If a different program is used for analysis, different parameters and limitations may be required than what were assumed in selecting the parameters given below. Thus, if a program other than LPile is used, **RKI** must be notified of the analysis method, so that we can review and revise our recommendations if required.

Assumed Behavior for Analysis	Material	c (psf)	k_s (pci)	ε_{50}	γ (pcf)	γ'(pcf)	q_u (psi)
Soft Clay (Matlock)	Soil Overburden	500	30	0.020	115	53	----
Strong Rock (Vuggy Limestone)	Limestone	----	----	----	140	78	1,000[(1)]

(1) Based on our experience with the Edwards Limestone formation.

Where:

c = undrained cohesion
k_s = p-y modulus
ε_{50} = strain factor
γ = total unit weight
γ' = effective unit weight
q_u = unconfined compressive strength

The values presented above for subgrade modulus and the strain at 50% are based on recommended values for the LPile program for the strength of materials encountered in our borings and are not necessarily based on laboratory test results.

The parameters presented in the above table do **not** include factors of safety nor have they been factored. It should be noted that where piers are spaced closer than three shaft diameters center to center, a modification factor should be applied to the p-y curves to account for a group effect. We recommend the following p-Multipliers for the corresponding center to center pier spacing to determine factored lateral loads. The reduction factors presented below are applicable for lateral resistance but is not intended for use to reduce the allowable bearing or side shear resistance values presented for axial capacity. If piers are utilized that impede the 3-shaft diameter spacing, reduction values should be evaluated on a case-by-case basis when the pier geometries, spacing, and loading are available.

Spacing (in shaft diameters)	p-Multiplier
3	1.0
2	0.75
1	0.50

RETAINING STRUCTURES

Retaining walls and foundation stem walls are anticipated to accommodate potential grade changes; however, the locations, heights, and other important information are not available at this time. The following sections provide general information for evaluating lateral earth pressures, backfill compaction, drainage, and the footings for the walls. Discussion on vertical rock cuts is also provided herein.

LATERAL EARTH PRESSURES

Equivalent fluid density values for computation of lateral soil pressures acting on walls were evaluated for various types of backfill materials that may be placed behind the walls. These values, as well as corresponding lateral earth pressure coefficients and estimated unit weights, are presented in the following table.

Back Fill Type	Estimated Total Unit Weight (pcf)	Active Condition		At Rest Condition	
		Earth Pressure Coefficient, k_a	Equivalent Fluid Density (pcf)	Earth Pressure Coefficient, k_o	Equivalent Fluid Density (pcf)
Washed Gravel	135	0.29	40	0.45	60
Crushed Limestone	145	0.24	35	0.38	55
Clean Sand	120	0.33	40	0.50	60
Pit Run Clayey Gravels or Sands	135	0.32	45	0.48	65
Inorganic Clays of Low to Medium Plasticity (Liquid Limit less than 40 percent)	120	0.40	50	0.55	65
Clays	120	0.59	70	0.74	90

The values tabulated above under “Active Conditions” pertain to flexible retaining walls free to tilt outward as a result of lateral earth pressures. For rigid, non-yielding walls (i.e. foundation stem walls) the values under “At-Rest Conditions” should be used. For the above values to be valid for washed gravel, crushed limestone, clean sand, or pit clayey gravels/sands backfill, the backfill should be placed in a wedge extending upward and away from the edge of the wall footing at a 45-degree angle or flatter. If the materials are to be placed with a steeper wedge, the values for low to medium plasticity soil, given above, should be used.

The values presented above assume the surface of the backfill materials to be level. Sloping the surface of the backfill materials will increase the surcharge load acting on the structures. The above values also do not include the effect of surcharge loads such as construction equipment, vehicular loads, or future storage near the structures. Nor do the values account for possible hydrostatic pressures resulting from groundwater seepage entering and ponding within the retained backfill materials. As discussed later, the walls should be provided with a drain system to allow for the dissipation of water. Surcharge loads and groundwater pressures should be considered in designing any structures subjected to lateral pressures.

The onsite surficial dark brown clays exhibit significant shrink/swell characteristics. The use of clay soils as backfill against the proposed retaining structures is **not** recommended. These soils generally provide higher design active earthen pressures, as indicated above, but may also exert additional active pressures associated with swelling. Controlling the moisture and density of these materials during placement will help reduce the likelihood and magnitude of future active pressures due to swelling, but this is no guarantee.

BACKFILL COMPACTION

Placement and compaction of backfill behind the walls will be critical, particularly at locations where backfill will support adjacent near-grade foundations, floor slabs, and/or flatwork. **If the backfill is not properly compacted in these areas, the adjacent foundations floor slabs, or flatwork can be subject to settlement**.

To reduce potential settlement of adjacent foundations/flatwork, the backfill materials should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-113-E, Compaction Test, or 98 percent of maximum density as determined by ASTM D698. **To reduce the potential settlement, fills greater than 8 ft should be compacted to at least 95 percent of maximum density as determined by ASTM D 1557, Modified Compaction Test and should be crushed limestone conforming to the 2024 TxDOT Standard Specifications, Item 247 – Flexible Base, Type A, Grade 1-2**. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction. Note that free-draining gravel materials are not typically tested for density and moisture content, but rather monitored by observation. Each lift or layer of the backfill should be tested during the backfilling operations to document the degree of compaction. Within at least a 5-ft zone of the walls, we recommend that compaction be accomplished using hand-guided compaction equipment capable of achieving the maximum density in a series of 3 to 5 passes. Thinner lifts may be required to achieve the required level of compaction.

DRAINAGE

The use of drainage systems is a positive design step toward reducing the possibility of hydrostatic pressure acting against the retaining structures. Drainage may be provided by the use of a drain trench and pipe. The drainpipe should consist of a slotted, heavy duty, corrugated polyethylene pipe and should be installed and bedded according to the manufacturer's recommendations. The drain trench should be filled with gravel (meeting the requirements of ASTM D 448 coarse concrete aggregate Size No. 57 or 67) and extend from the base of the structure to within 2 ft of the top of the structure. The bottom of the drain trench will provide an envelope of gravel around the pipe with minimum dimensions consistent with the pipe manufacturer's recommendations. The gravel should be wrapped with a suitable geotextile fabric (such as Mirafi 140N or equivalent) to help minimize the intrusion of fine-grained soil particles into the drain system. The pipe should be sloped and equipped with clean-out access fittings consistent with state-of-the-practice plumbing procedures.

As an alternative to a full-height gravel drain trench behind the proposed retaining structures, consideration may be given to utilizing a manufactured geosynthetic material for wall drainage. A number of products are available to control hydrostatic pressures acting on earth retaining structures, including Amerdrain (manufactured by American Wick Drain Corp.), Miradrain (manufactured by Mirafi, Inc.), Enkadrain (manufactured by American Enka Company), and Geotech Insulated Drainage Panel (manufactured by Geotech Systems Corp.). The geosynthetics are placed directly against the retaining structures and are hydraulically connected to the gravel envelope located at the base of the structures.

Weepholes may be provided along the length of the proposed retaining structures, if desired, in addition to one of the two alternative drainage measures presented above. Based on our experience, weepholes, as the only drainage measure, often become clogged with time and do not provide the required level of drainage from behind retaining structures. We recommend that **RKI** review the final retaining structure drainage design before construction.

VERTICAL ROCK CUTS

The project site is underlain by the Edward Limestone formation. The Edward Limestone is karstic and may have undergone variable degrees of weathering (i.e. fractures, voids, clay filled voids, caves, weathered material, or other solution features). Where competent limestone bedrock is exposed, cuts into this material may be performed vertically. However, it is not uncommon to encounter karstic features in the limestone bedrock. Exposed limestone bedrock that contains these features can exhibit a characteristic mode of slope failure known as raveling. This failure mechanism involves raveling of the rock/other material along fractures, bedding planes, seams, and other pre-existing planes of weakness, resulting in the separation of blocks, weathered material or soil. Cobble- to boulder-sized blocks will eventually become dislodged as the result of this process and fall from the cut wall. The raveling process can be exacerbated by the presence of existing dissolution or karstic features in the rock, and by discharge of perched groundwater, if any, through the face of the rock cut.

Owing to increased moisture conditions typically associated with fractures, tree roots and other vegetation tend to exploit these weaknesses in the rock outcrop and serve to enhance the rate of erosion. As tree roots, etc. proliferate through fractures, fractures are enlarged owing to both mechanical and chemical erosional processes. Raveling failures can be expected to occur more frequently when these conditions occur.

In most instances, near-vertical rock slopes or cuts can be unprotected and unsupported provided that an adequate catchment area or buffer area is provided at the toe to prevent rockfall from affecting adjacent improvements. A flat catchment area should be at least 0.5 times the height in width. In areas where adequate catchment cannot be provided due to right-of-way or other geometrical constraints, the slope should be protected from raveling and differential erosion or laid back at a 1 Vertical to 1 Horizontal slope, or flatter. In addition to these protective measures, seepage, and surface water control to prevent stormwater from flowing over and down the face of the cut are essential in minimizing raveling and erosion.

For fixed-head walls that may be formed against the exposed competent limestone bedrock, we recommend that the following lateral pressure be used:

$$p_h = 45h + 0.3q \text{ (for fixed-head walls)}$$

Where:

p_h = lateral pressure at any depth h, psf
h = depth below adjacent grade, feet
q = surcharge loads, psf

The above equation does not account for hydrostatic pressures. The walls should be designed to withstand the hydrostatic pressures and/or designed with a drainage system.

FOUNDATION CONSTRUCTION CONSIDERATIONS

SITE DRAINAGE

Drainage is an important key to the successful performance of any foundation. Good surface drainage should be established prior to and maintained after construction to help prevent water from ponding within or adjacent to the foundation and to facilitate rapid drainage away from the foundation. Failure to provide positive drainage away from the structure can result in localized differential vertical movements in soil supported foundations and floor slabs.

Current ordinances, in compliance with the Americans with Disabilities Act (ADA), may dictate maximum slopes for walks and drives around and into new structures. These slope requirements can result in drainage problems for structures supported on expansive soils. We recommend that, on all sides of the structure, the maximum permissible slope be provided away from the structure.

Where a select fill overbuild is provided outside of the floor slab/foundation footprint, if any, the surface should be sealed with an impermeable layer (pavement or clay cap) to reduce infiltration of both irrigation and surface waters. Careful consideration should also be given to the location of water bearing utilities, as well as to provisions for drainage in the event of leaks in water bearing utilities. All leaks should be immediately repaired.

SITE PREPARATION

All the areas to support select fill/slab should be stripped of all vegetation, organic topsoil, existing fill, if any, pavements, utilities and associated backfill.

Exposed subgrades should be thoroughly proofrolled in order to locate weak, compressible zones. A fully-loaded tandem wheeled dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or their representative to document subgrade condition and preparation. Weak or soft areas identified during proofrolling should be removed and replaced with suitable, compacted engineered fill, free of organics, oversized materials, and degradable or deleterious materials.

In areas where clay will remain in place or where clays remain after stripping, the exposed subgrade should be moisture conditioned. This should be done after completion of the proofrolling operations and just prior to fill placement and/or slab/foundation construction. Moisture conditioning is done by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum density determined from TxDOT, Tex-114-E or ASTM D698, Compaction Test. The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum moisture content until permanently covered. Moisture conditioning of the subgrade may be waived where native, intact limestone is exposed.

ONSITE SOIL

The use of onsite expansive soils may be a considered for general fill (outside of the building footprint) if the potential vertical movements in excess of those discussed previously will not adversely impact either

the structural or operational tolerances for the proposed improvements for which this material is being considered.

ON-SITE ROCK FILL

If excavations extend to significant depths into the limestone formation, consideration can be given to utilizing the excavated limestone for select fill. However, processing of the excavated material will be required to reduce the maximum particle size to 4 in. Furthermore, special care will be required during excavation activities to separate organics and any plastic clay seams encountered. In addition, the processed material must meet the specifications given above for alternative select fill materials. If on-site materials cannot be processed to meet the required criteria, imported select fill materials should be utilized.

SELECT FILL

Materials used as select fill preferably should be imported crushed limestone base materials consisting of crushed stone or gravel aggregate. We recommend that materials specified for use as select fill meet the TxDOT 2024 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 247, Flexible Base, Type A or B, Grades 1-2 or 3.

Soils classified as CH, MH, ML, SM, GM, OH, OL and Pt under the USCS are not considered suitable for use as select fill materials at this site.

Select Fill Placement and Compaction

Select fill should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-113-E, Compaction Test, or 98 percent of maximum density as determined by ASTM D698. If fill materials supporting movement sensitive structures are placed that are 8 ft or thicker, we recommend that ASTM D1557 Modified Compaction Test be utilized in lieu of the above compaction methods. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction for imported crushed limestone base.

General Fill Placement and Compaction

The remaining fill may be compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-114-E, Compaction Test, or ASTM D698. The moisture content of the fill should be maintained within the range of optimum to plus 3 percentage points above the optimum moisture content until final compaction.

SHALLOW FOUNDATION EXCAVATIONS

Shallow foundation excavations should be observed by the Geotechnical Engineer or their representative prior to placement of reinforcing steel and concrete. This is necessary to observe that the bearing soils at the bottom of the excavations are similar to those encountered in our boring and that excessive loose materials and water are not present in the excavations. If soft pockets of soil are encountered in the

foundation excavations, they should be removed and replaced with a compacted non-expansive fill material or lean concrete up to the design foundation bearing elevations.

DRILLED PIERS

Each drilled pier excavation must be examined by an **RKI** representative who is familiar with the geotechnical aspects of the soil stratigraphy, the structural configuration, foundation design details and assumptions, prior to placing concrete. This is to observe that:

- The shaft has been excavated to the specified dimensions at the correct depth established by the previously mentioned criteria;
- An acceptable portion of the shaft penetrates intact limestone versus weathered and/or clay seams;
- The shaft has been drilled plumb within specified tolerances along its total length; and
- Excessive cuttings, buildup and soft, compressible materials have been removed from the bottom of the excavation.

If clay seams and/or voids are encountered within the limestone formation during drilled shaft excavations, the shafts must be extended to develop the required side shear resistance. For bid purposes, the owner should anticipate that deeper piers will be required in some areas. Consequently, contractors bidding on the job should include unit costs for various depths of additional pier embedment. Unit costs should include those for both greater and lesser depth in both rock and soil.

Reinforcement and Concrete Placement

Reinforcing steel should be checked for size and placement prior to concrete placement. Placement of concrete should be accomplished as soon as possible after excavation to reduce changes in the moisture content or the state of stress of the foundation materials. No foundation element should be left open overnight without concreting.

EXCAVATIONS AND TEMPORARY SLOPES

Depending on the planned improvement depth(s), temporary slopes or retention systems may be required. In areas where back slopes are feasible and have heights less than 20 ft, excavation slopes should be consistent with safety regulations. Worker safety and classification of soil type is the responsibility of the contractor. The surficial soils encountered during the borings are anticipated to consist of relatively hard fine-grained soils. Hence, temporary slopes should be classified as OSHA Type A soil. Excavations into intact/competent bedrock may be performed vertically. If weathered bedrock is encountered and depending on the degree of weathering, this material may be considered as Type A material. Additional recommendations are provided in the *Vertical Rock Cuts* section of this report.

For Type A material, the temporary slopes may be constructed at 3/4V:1H. Excavations extending deeper than 20 ft must be evaluated by a professional engineer.

The contractor should be aware that excavation depths and inclinations (including adjacent existing slopes) should not exceed those specified in local, state, or federal safety regulations, e.g., OSHA Health and Safety

Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if not followed, the contractor, or earthwork or utility subcontractors could be subjected to substantial penalties. Construction site safety is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations.

Temporary slopes left open may undergo sloughing and result in an unstable situation. The contractor should evaluate stability and failure consequences before open cut slopes are made. Minor sloughing of open face slopes may occur. If the slope is expected to remain open for an extended time, an impermeable membrane covering the slopes could be considered as a means to reduce the potential for slope degradation and instability.

It is important to note that soils encountered in the construction excavations may vary across the site and that even if the OSHA criteria are used, there is a potential for slope failure. If different subsurface conditions are encountered at the time of construction, **RKI** should be contacted to evaluate the conditions encountered.

An excavated temporary slope may not be feasible at all locations, and a temporary retention system may be required. While many different types and configurations of retention systems can be used, the more common include trench boxes or braced systems. The design of the system should be performed by the contractor that performs the work. The design should account for the possibility of overexcavating unsuitable or disturbed subgrades. The contractor should also be responsible for monitoring the performance of the retention system. OSHA regulations should be followed with respect to bracing requirements. Worker safety and classification of soil type is the responsibility of the contractor.

EXCAVATION EQUIPMENT

Please note that limestone bedrock was encountered in our boring at relatively shallow depths below the existing ground surface. Therefore, excavations at this site will require removal of the underlying rock formation. The Edwards limestone is hard to very hard in induration, is massive, and commonly contains chert seams. Consequently, excavations penetrating the rock will encounter hard to very hard materials and may be difficult to remove in narrow trenches or footing excavations. **Excavation costs should anticipate hard rock excavation for preliminary planning and construction budget.** Our boring log is not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. We recommend that earthwork and utility contractors interested in bidding on the work perform their own tests in the form of test pits to determine the quantities of the different materials to be excavated, as well as the preferred excavation methods and equipment for this site.

UTILITIES

Utilities which project through any rigid unit should be designed with either some degree of flexibility or with sleeves. Such design features will help reduce the risk of damage to the utility lines as vertical movements occur.

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is

increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches (such as fractures within a rock mass or at contacts between rock and clay formations). It is our belief that another factor which can significantly impact settlement is the migration of fines within the backfill into the open voids in the underlying free-draining bedding material.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented. Trench backfill materials should be placed in loose lifts not exceeding 8 inches in thickness and compacted to at least 95 percent of maximum density as determined by TxDOT, Tex-113-E or Tex-114-E, Compaction Test.
- The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content for non-cohesive soils and maintained within the range of optimum to 3 percentage points above optimum moisture content for cohesive soils until final compaction.
- Consideration should be given to wrapping free-draining bedding gravels with a geotextile fabric (similar to Mirafi 140N) to reduce the infiltration and loss of fines from backfill material into the interstitial voids in bedding materials.

CONSTRUCTION RELATED SERVICES

CONSTRUCTION MATERIALS TESTING AND OBSERVATION SERVICES

As presented in the attachment to this report, *Important Information About Your Geotechnical Engineering Report*, subsurface conditions can vary across a project site. The conditions described in this report are based on interpolations derived from a limited number of data points. Variations will be encountered during construction, and only the geotechnical design engineer will be able to determine if these conditions are different than those assumed for design.

Construction problems resulting from variations or anomalies in subsurface conditions are among the most prevalent on construction projects and often lead to delays, changes, cost overruns, and disputes. These variations and anomalies can best be addressed if the geotechnical engineer of record, **RKI** is retained to perform construction observation and testing services during the construction of the project. This is because:

- **RKI** has an intimate understanding of the geotechnical engineering report's findings and recommendations. **RKI** understands how the report should be interpreted and can provide such interpretations on site, on the client's behalf.
- **RKI** knows what subsurface conditions are anticipated at the site.
- **RKI** is familiar with the goals of the owner and project design professionals, having worked with them in the development of the geotechnical workscope. This enables **RKI** to suggest remedial measures (when needed) which help meet the owner's and the design teams' requirements.

- **RKI** has a vested interest in client satisfaction, and thus assigns qualified personnel whose principal concern is client satisfaction. This concern is exhibited by the manner in which contractors' work is tested, evaluated, and reported, and in selection of alternative approaches when such may become necessary.
- **RKI** cannot be held accountable for problems which result due to misinterpretation of our findings or recommendations when we are not on hand to provide the interpretation which is required.

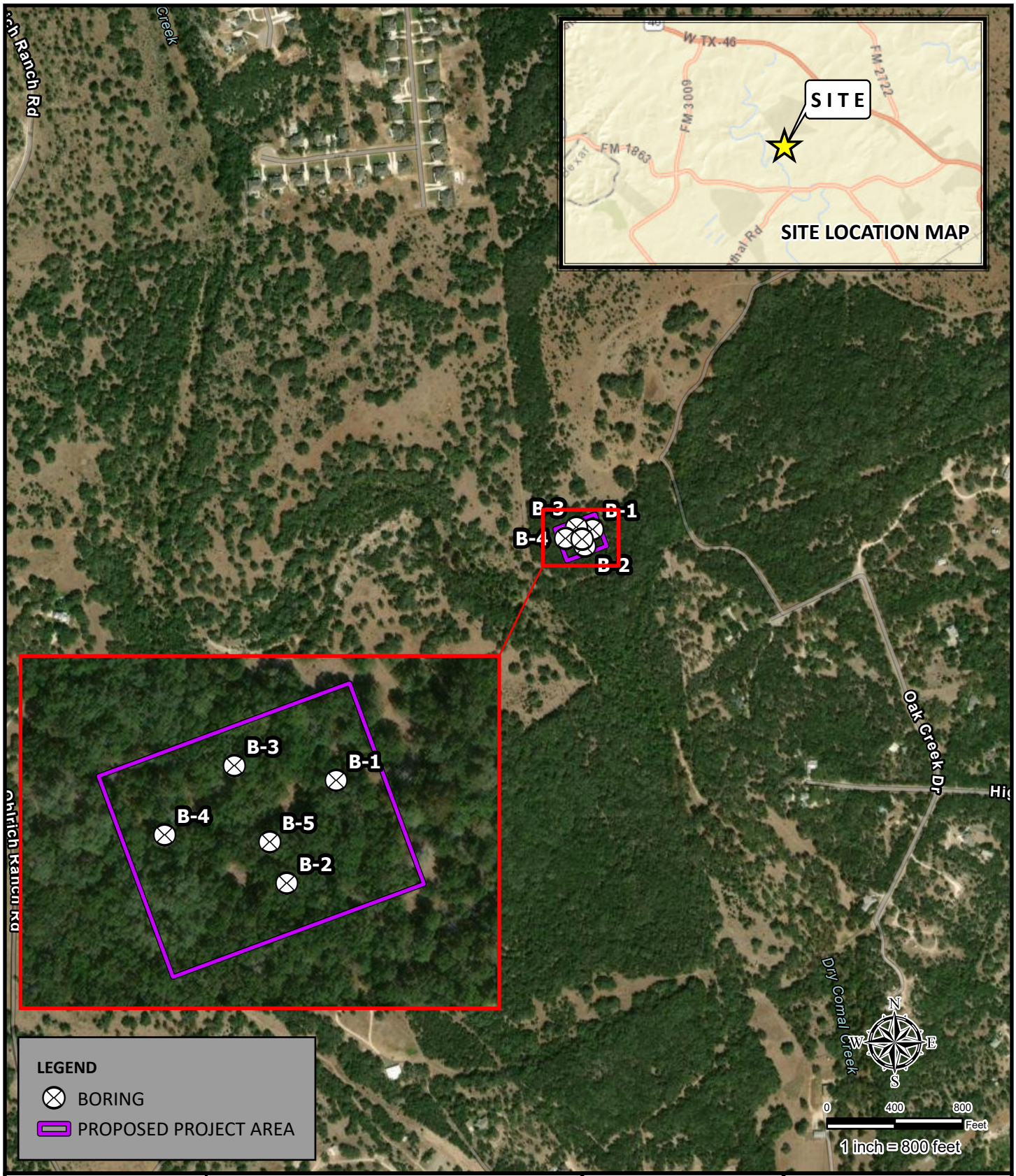
BUDGETING FOR CONSTRUCTION TESTING

Appropriate budgets need to be developed for the required construction testing and observation activities. At the appropriate time before construction, we advise that **RKI** and the project designers meet and jointly develop the testing budgets, as well as review the testing specifications as it pertains to this project.

Once the construction testing budget and scope of work are finalized, we encourage a preconstruction meeting with the selected contractor to review the scope of work to make sure it is consistent with the construction means and methods proposed by the contractor. **RKI** looks forward to the opportunity to provide continued support on this project and would welcome the opportunity to meet with the Project Team to develop both the scope and budget for these services.

* * * * * * * * * * * * * * * * * * *

ATTACHMENTS



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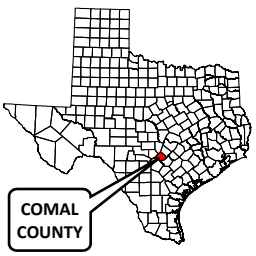
BORING LOCATION MAP

Lift Station and WWTF
NB West
New Braunfels, Texas



PROJECT No.:	ANA24-027-00
ISSUE DATE:	8/8/2024
DRAWN BY:	BM
CHECKED BY:	SS
REVIEWED BY:	TIP

FIGURE
1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Lift Station and Waste Water Treatment Facility
NB West
New Braunfels, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger & Air Rotary

LOCATION: N 29.72318; W 98.25983

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			FAT CLAY, Hard, Dark Brown, with limestone fragments	35			36	
			LIMESTONE, Hard, Tan and Gray	ref/1"				
5				ref/1"				
				ref/2"				
				ref/1"				
10								
				ref/1"				
15			- highly weathered from 16 to 18 ft with clay seams					
				ref/2"				
20								
				ref/1"				
25								
				ref/1"				
30								
				ref/2"				
35								
				ref/1"				
			Boring Terminated					
40								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	38.6 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA24-027-00
DATE DRILLED:	9/6/2024	**DATE MEASURED:**	9/6/2024	**FIGURE:**	2

LOG OF BORING NO. B-2

Lift Station and Waste Water Treatment Facility
NB West
New Braunfels, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Air Rotary

LOCATION: N 29.72288; W 98.26000

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0)	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
0	FAT CLAY, Hard, Dark Brown, with limestone fragments	48				32	
2	LIMESTONE, Hard, Tan and Gray, with weathered seams	ref/3"					
5		ref/1"				10	
7		ref/1"					
9		ref/1"					
14		ref/1"					
19		ref/1"					
24		ref/2"					
29		ref/1"					
34		ref/2"					
38.6	Boring Terminated	ref/1"					
40							

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	38.6 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA24-027-00
DATE DRILLED:	9/6/2024	**DATE MEASURED:**	9/6/2024	**FIGURE:**	3

LOG OF BORING NO. B-3

Lift Station and Waste Water Treatment Facility
NB West
New Braunfels, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Air Rotary

LOCATION: N 29.72312; W 98.26010

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	FAT CLAY, Hard, Dark Brown, with limestone fragments	50/8"			
	MARL, Hard, Tan, with limestone fragments	50/10"		17	
5		50/7"			
		50/10"			
		50/2"		17	
10					
	LIMESTONE, Hard, Tan and Gray, with weathered seams	ref/2"			
15					
		ref/2"			
20					
		ref/2"			
25					
	- with reddish brown clay from 27 to 35				
30		50/8"			
		50/8"			
35	Boring Terminated				
40					

SHEAR STRENGTH, TONS/FT^2
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT
10 20 30 40 50 60 70 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	34.7 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA24-027-00
DATE DRILLED:	9/10/2024	**DATE MEASURED:**	9/10/2024	**FIGURE:**	4

LOG OF BORING NO. B-4

Lift Station and Waste Water Treatment Facility
NB West
New Braunfels, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Air Rotary

LOCATION: N 29.72299; W 98.26036

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT²	PLASTICITY INDEX	% -200
			FAT CLAY, Hard, Dark Brown, with limestone fragments	30			51	
				50/9"				
5			MARL, Hard, Tan, with clay seams limestone fragments	50/2"				
				ref/4"				
10				ref/2"			6	
15			LIMESTONE, Hard, Tan and Gray, with weathered seams	ref/1"				
				ref/2"				
20								
25				ref/1"				
				ref/2"				
30								
35				ref/2"				
				ref/2"				
40			Boring Terminated					

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT

10 20 30 40 50 60 70 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	38.7 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA24-027-00
DATE DRILLED:	9/10/2024	**DATE MEASURED:**	9/10/2024	**FIGURE:**	5

LOG OF BORING NO. B-5

Lift Station and Waste Water Treatment Facility
NB West
New Braunfels, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Air Rotary

LOCATION: N 29.72296; W 98.26009

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0; PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT; 10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
0			FAT CLAY, Hard, Dark Brown, with limestone fragments	39			39	
2				ref/4"				
			LIMESTONE, Hard, Tan and Gray, with weathered seams	ref/2"				
5				ref/1"				
				ref/1"				
10								
				ref/2"				
15								
				ref/1"				
20								
				ref/1"				
25								
			- with reddish brown clay seams from 27 to 30	ref/4"				
30								
				ref/2"				
35								
				ref/1"				
38.6			Boring Terminated					
40								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	38.6 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA24-027-00
DATE DRILLED:	9/6/2024	**DATE MEASURED:**	9/6/2024	**FIGURE:**	6

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS


CALCAREOUS


CALICHE


CLAY


CLAYEY


GRAVEL


GRAVELLY


PEAT


SAND


SANDY


SILT


SILTY


FILL

ROCK TERMS


CHALK


CLAYSTONE


CLAY-SHALE


CONGLOMERATE


DOLOMITE


IGNEOUS


LIMESTONE


MARL


METAMORPHIC


SANDSTONE


SHALE


SILTSTONE

OTHER


ASPHALT


BASE


CONCRETE/CEMENT


BRICKS / PAVERS


WASTE


NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS


BLANK PIPE


SCREEN


BENTONITE


CEMENT GROUT


BENTONITE & CUTTINGS


CONCRETE/CEMENT


CUTTINGS


GRAVEL


SAND


VOLCLAY

SAMPLE TYPES

AIR ROTARY

MUD ROTARY

SHELBY TUBE

GRAB SAMPLE

NO RECOVERY

SPLIT BARREL

CORE

NX CORE

SPLIT SPOON

GEOPROBE SAMPLER

PITCHER

TEXAS CONE PENETROMETER

ROTOSONIC -DAMAGED

ROTOSONIC -INTACT

DISTURBED

STRENGTH TEST TYPES

POCKET PENETROMETER

TORVANE

UNCONFINED COMPRESSION

TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED

TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ANA24-027-00

RABAKISTNER

REVISED 04/2012

FIGURE 7a

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Lift Station and Waste Water Treatment Facility
NB West
New Braunfels, Texas

FILE NAME: ANA24-027-00 GINT.GPJ 10/14/2024

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	0.0 to 1.5	35	9	51	15	36	CH				
	2.5 to 2.6	ref/1"	2								
	4.5 to 4.6	ref/1"	1								
	6.5 to 6.7	ref/2"	1								
	8.5 to 8.6	ref/1"	0								
	13.5 to 13.6	ref/1"	0								
	18.5 to 18.7	ref/2"	1								
	23.5 to 23.6	ref/1"	1								
	28.5 to 28.6	ref/1"	1								
	33.5 to 33.7	ref/2"	1								
	38.5 to 38.6	ref/1"	2								
B-2	0.0 to 1.5	48	12	48	16	32	CH				
	2.5 to 2.8	ref/3"	1								
	4.5 to 4.6	ref/1"	1	23	13	10	CL				
	6.5 to 6.6	ref/1"	1								
	8.5 to 8.6	ref/1"	1								
	13.5 to 13.6	ref/1"	1								
	18.5 to 18.6	ref/1"	2								
	23.5 to 23.7	ref/2"	1								
	28.5 to 28.6	ref/1"	0								
	33.5 to 33.7	ref/2"	1								
	38.5 to 38.6	ref/1"	1								
B-3	0.0 to 1.1	50/8"									
	0.5 to 1.1		4								
	2.5 to 3.8	50/10"	6	35	18	17	CL				
	4.5 to 5.6	50/7"	7								
	6.5 to 7.8	50/10"	9								
	8.5 to 9.2	50/2"	3	31	14	17	CL				
	13.5 to 13.6	ref/2"	1								
	18.5 to 18.6	ref/2"	1								
	23.5 to 23.6	ref/2"	1								
	28.5 to 29.7	50/8"	1								
	33.5 to 34.7	50/8"	7								
B-4	0.0 to 1.5	30	11	72	21	51	CL				
	2.5 to 3.7	50/9"	13								
	4.5 to 5.2	50/2"	4								
	6.5 to 6.8	ref/4"	3								
	8.5 to 8.7	ref/2"	2	21	15	6	CL				
	13.5 to 13.6	ref/1"	2								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ANA24-027-00

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Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-4	18.5 to 18.7	ref/2"	1								
	23.5 to 23.6	ref/1"	0								
	28.5 to 28.7	ref/2"	0								
	33.5 to 33.7	ref/2"	0								
	38.5 to 38.7	ref/2"	1								
B-5	0.0 to 1.5	39	8	56	17	39	CH				
	2.5 to 2.8	ref/4"	17								
	4.5 to 4.7	ref/2"	1								
	6.5 to 6.6	ref/1"	0								
	8.5 to 8.6	ref/1"	0								
	13.5 to 13.7	ref/2"	0								
	18.5 to 18.6	ref/1"	1								
	23.5 to 23.6	ref/1"	1								
	28.5 to 28.8	ref/4"	2								
	33.5 to 33.7	ref/2"	1								
	38.5 to 38.6	ref/1"	0								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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