Project Manual
Including Specifications for
The Construction of

SANTA FE COUNTY
ABAJO LIFT STATION RE-DIRECT
Santa Fe, New Mexico
September 2025

OWNER:

SANTA FE COUNTY
424 NM SR 599
Santa Fe, New Mexico 87507

ENGINEER:

MOLZEN CORBIN
2701 Miles Road, SE
Albuquerque, New Mexico 87106

ENGINEER OF RECORD

Molzen Corbin
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The technical material and data contained in the Specifications were prepared under the supervision and direction of the undersigned, whose seal as a Professional Engineer, licensed to practice in the State of New Mexico, is affixed below.

Steven K. Morrow, P.E.

N.M.P.E. No. 13679

All questions about the meaning or intent of these documents shall be submitted only to the Engineer of Record, stated above, in writing.

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DIVISION 01 – GENERAL REQUIREMENTS

SECTION 01 00 01

SPECIFICATION FORMAT

PART 1 GENERAL

1.01 FORMAT

A. The Division 1 through 48 Specifications are written in imperative and abbreviated form. This imperative language is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting “shall”, “the Contractor shall”, and “shall be” or similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words “shall be” are to be placed by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, the Contractor shall fulfill (perform) all indicated requirements whether stated imperatively or otherwise.

B. All equipment and facilities shall be furnished, installed, and constructed by the Contractor to provide the Owner with complete, ready to use components, systems, and facilities. All necessary materials and Work required to accomplish this are the responsibility of the Contractor alone, whether or not specifically indicated on the Drawings or stated in the Specifications.

C. The various Sections of the Division 1 through 48 Specifications may contain references to standards, other specification sections, or items that do not apply to the Work covered in this project. These inappropriate references are to be considered irrelevant and ignored by the Contractor. If conflicts arise from erroneous references or lack of references to standards or other specification sections, Engineer will determine the relevancy of the apparent conflicts.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK INCLUDED

A. Work under this Contract consists of constructing a new wastewater lift station and approximately 1-mile of pressurized sewer line in accordance with the Drawings and these Specifications for Santa Fe County.

1.02 DESCRIPTION

A. Work included under this Contract:
   1. Construct approximately 5,440 feet of 12-inch HDPE pressurized sewer line with associated air release/vacuum valve stations, cleanouts and appurtenances.
   2. Construct two (2) jack and bore crossings under state highways for 12-inch waterline.
   3. Construct new Abajo Lift Station and related site improvements adjacent to the existing Abajo Lift Station.

1.03 CONTRACT

A. The Work shall be performed under unit prices bid items and reimbursable allowances.

1.04 SUMMARY BY REFERENCES

A. Work of the Contract can be summarized by references to the Contract, General Conditions, Supplementary Conditions, Specification Sections, Drawings, Addenda and Modifications to the Contract Documents issued subsequent to the initial printing of this Project Manual and including, but not necessarily limited to, printed material referenced by any of these. It is recognized that work of the Contract is also unavoidably affected or influenced by governing regulations, natural phenomenon, including weather conditions and other forces outside the Contract Documents.

1.05 CONTRACTOR USE OF THE PREMISES

A. The immediate premises of work will be at the disposal of the Contractor during the construction period.

1.06 SPECIAL CONDITIONS (NOT USED)

1.07 FILL MATERIAL

A. All fill material provided by Contractor shall be in full compliance with requirements stipulated in Section 31 23 00 – Excavation and Fill, Section 31 23 33 – Trenching and Backfilling, and where specified elsewhere in the Contract Documents.

B. Contractor is solely responsible for providing suitable backfill material where needed at no additional cost to Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXECUTION

A. General: Immediately after award of the Contract, thoroughly and clearly advise all necessary personnel as to the nature and extent of the project.

END OF SECTION

SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 WORK SEQUENCE

A. Contractor shall coordinate and schedule the work in the following sequence:
   1. Construct 12-inch HDPE force main, jack and bore crossings of highway, and lift station facilities concurrently.
   2. The Contractor shall install plug valve on the existing sewer which flows to the existing Abajo Lift Station and the plug valve on the new sewer to the new Abajo Lift Station to allow influent sewer to flow to either lift station.
   3. Successfully complete all tests required for the submersible pumps and forcemain.
   4. Upon completion of the forcemain and lift station facilities, inform the Engineer in writing that all associated facilities are ready for lift station startup and shakedown operations.

1.02 SCHEDULING CONSTRAINTS

A. Sewer Service to the existing Abajo Lift Station: Maintain service to the existing Abajo Lift Station and forcemain to the City of Santa Fe during construction.

B. The existing Abajo Lift Station shall remain in service throughout the project until the new lift station is approved and ready for service by the Engineer and Owner.

C. Coordinate any disruptions in service with Owner not less than seven (7) working days prior to initiating any work affecting sewer utilities. Limit sewer service disruptions to four (4) hours.

D. Contractor shall complete all work while maintaining all work activities within the construction limits shown on the Drawings.

1.03 RELATED SECTIONS

A. Section 01 91 01 – Lift Station Shakedown Operations.

1.04 SUBSTANTIAL COMPLETION

A. Refer to Section 01 77 00 – Contract Closeout, for description of Substantial Completion.

1.05 ADJUSTMENTS TO SEQUENCING REQUIREMENTS

A. The Owner may require the Contractor to make adjustments to the requirements of this Section to accommodate unforeseen conditions and situations. Reasonable adjustments shall be made by the Contractor at no additional cost to the Owner or additional Contract Time.

1.06 TIME EXTENSIONS FOR ABNORMAL AND UNFORSEEABLE WEATHER (ADVERSE WEATHER DELAYS)

A. This provision specifies the procedure for the determination of time extensions for abnormal and unforeseeable weather in accordance with General Conditions Section 12.03 – Delays. In order for the Engineer to award a time extension under this clause, the following conditions must be satisfied:
   1. The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.
   2. The abnormal and unforeseeable weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the Contractor.

B. The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The Contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

Monthly Anticipated Adverse Weather Delay
Work Days Based on 5-Day Work Week

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1	1	1	1	1	3	4	3	3	1	1

C. An actual adverse weather day must prevent work for 50 percent or more of the Contractor's workday, delay work critical to the timely completion of the project, and be documented by the Contractor. The Owner's representative observing the construction shall determine on a daily basis whether or not work can proceed on a given date, within 2 calendar days of that date. The Owner will use the above written notification in determining the number of working days for which work was delayed during each month.

D. The number of actual adverse weather delay days shall include days impacted by actual adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day of each month, and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph (B), above, the Engineer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair

weather work days, and issue a modification in accordance with the General Conditions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 02

UTILITY OBSTRUCTIONS

PART 1 GENERAL

1.01 WORK INCLUDED

A. General provisions for handling utility obstructions and relocations.

1.02 UTILITIES SHOWN ON DRAWINGS

A. The Engineer has made reasonable efforts to show the general location of existing underground and overhead utility lines on the Drawings; however, Contractor shall recognize that buried utilities may not be in the locations shown on the Drawings, or there may be other utilities that are not shown on the Drawings.

1.03 CONTRACTOR RESPONSIBILITIES

A. For excavation work in New Mexico, Contractor is responsible to comply with the New Mexico Excavation Law (NMEL), as published in New Mexico Statutes Annotated (NMSA) 1978, section 62-14. Section 62-14-3 of the law requires the excavating Contractor to:
   1. Call the local notification center of NM811 One-Call in advance of excavating.
   2. NM811 One-Call will notify utility owners or operators to locate and mark their utilities.
   3. Notify directly all utility owners or operators who are not members of the local one-call center to locate and mark their utilities.
   4. In general, any utility located on the Owner's plant or station property belongs to the Owner past the utility meter or other termination point. The Owner is responsible to locate and mark such utilities.
   5. Do not start excavation until all utility owners have located and marked their utilities.
   6. Do not use mechanical excavation equipment, including bores and plows, within 18-inches horizontally of the utility marks (tolerance zone) and continue excavation in a manner necessary to prevent damage.
   7. Repair any damage to utilities caused by Contractor, and report to utility owner and NM811 One-Call.

B. Additional Owner Requirements:
   1. Use non-mechanical means of excavating within 18-inches of marked utilities to expose the utilities such as by hand digging or vacuum/dry type potholing.

C. This work will be considered incidental Work to the Contract Documents' bid items.

1.04 RELOCATION OF OVERHEAD UTILITIES

A. Determine in advance of construction operations if overhead utility lines, support structures, poles, guys, etc., whether shown on the Drawings or not, will obstruct construction operations. If any obstruction to construction operations is evident, coordinate with the appropriate utility company to remove or relocate the utility obstructions. Any charges by any utility company for removal or relocation of overhead utilities are the sole responsibility of the Contractor at no additional cost to the Owner.

1.05 RELOCATION OF UNDERGROUND UTILITIES

A. Determine in advance of construction operations locations of all underground utilities (gas, telephone, fiber optic cable, electrical, cable TV, water, sewer), whether shown on the Drawings or not, that may interfere with Contractor's construction operations.

B. All Underground Utilities Except Water and Sewer Lines: Coordinate with the appropriate utility company to remove or relocate the existing utilities which interfere with construction. Utility company charges for relocating these existing utilities will be paid from the utility line relocation allowance listed on the Bid Proposal.

C. Water and Sewer Lines:
1. Adjust alignment on any waterline which Contractor is constructing to avoid existing underground utility lines and/or to maintain a minimum three feet of cover; Take other measures necessary (encasement of water or sewer line, change of pipe material, etc.) to protect new and existing lines.
2. Adjust alignment of all existing waterlines as appropriate or required to avoid interference with:
3. new sewer lines, or;
4. new structures, or;
5. new roadway, or;
6. to maintain at least three feet of cover over existing waterlines unless otherwise approved in writing by Engineer.
7. The following incidental work to be performed at no additional cost to Owner: All work required to adjust alignment of new waterlines around any existing waterlines or sewer lines, or other measures necessary to protect new and existing lines.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 03

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 APPLICABLE CODES AND ORDINANCES

A. All Work shall conform to the current versions of all applicable building, mechanical, plumbing, and electrical codes.

B. Contractor is responsible for acquiring all applicable building, mechanical, plumbing, and electrical permits related to this project.

C. Comply with all local laws, ordinances, and regulations which may impact Contractor's work.

1.02 OSHA REQUIREMENTS

A. All equipment and facilities provided, including but not limited to, handrails, guardrails, grating, hoists, equipment guards, ladders, etc., shall meet OSHA requirements whether or not such requirements are specifically indicated or described in the Contract Documents.

B. Any conflicts between OSHA requirements and Contract Documents shall be brought to the attention of the Engineer on a timely basis for resolution.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 16.01

COORDINATION WITH PUBLIC AND UTILITY INTERRUPTIONS

PART 1 GENERAL

1.01 PUBLIC ACCESS

A. Provide for continuous public access to all residences, businesses, and properties via existing roads, alleys, and driveways whenever practical.

B. Provide alternate public access to all residences, businesses, and properties in coordination with affected residents and occupants when existing access arrangements must be disrupted by Contractor's work whenever practical.

C. Notify public at least three (3) calendar days in advance of interrupting public access.

1.02 UTILITY INTERRUPTIONS

A. Coordinate any water shut-off operation with the Owner not less than three (3) working days prior to initiating any work affecting existing water utilities. Limit water service shut-off to four (4) hours. Keep Owner informed of work areas on a daily basis, and specifically notify Owner of areas where fire hydrants will be out of service.

B. Notify all customers at least three (3) calendar days in advance of interrupting utility service.

C. Keep interruptions of utility service at a minimum as to number of users and duration.

1.03 NOTICES

A. Construction Notices Before Construction:
   1. Delivered not more than seven (7) calendar days nor less than four (4) calendar days prior to actual physical construction on each line or line segment.
   2. Corrected notices delivered if construction does not start within 48 hours of date given in notice.
   3. Written notice to state:
      a. Contractor's name, address, and local telephone number.
      b. Nature of work to be done.
      c. Disruption residents or businesses might expect.
      d. Expected duration of construction.
      e. Contractor's local telephone number to which complaints may be made during normal working hours.
      f. Contractor's local telephone number to which emergency conditions can be reported during non-working periods.

B. Construction Notices After Construction:
   1. Delivered not more than seven (7) calendar days following construction on each line or line segment.
   2. Written notice to state:
      a. Contractor's name, address, and telephone number.
      b. Thank residents and businesses for cooperation and report work is completed in applicable area.

C. Special Notices:
   1. Inform residents and businesses personally and by written notice whenever access to property will be impaired or utility service will be interrupted, stating scheduling of such action.

D. Notice Delivery:
   1. Hand delivery to each resident and business adjacent to or which may be reasonably expected to be affected by construction.
   2. Do not deliver notices in mail boxes or mail slots. Use other delivery methods such as door hangers.

1.04 SCHEDULE OF SPECIAL REQUIREMENTS FOR THIS PROJECT

A. Provide all notices included above.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED

END OF SECTION

SECTION 01 14 19

USE OF SITE

PART 1 GENERAL

1.01 AVAILABLE SITES

A. Sites and easement limits available for the construction of the project are shown on the Drawings. Contractor shall not utilize any land not indicated as being available without the written approval of the applicable land owner.

B. If the Contractor requires the entire width of right-of-way or easement for construction, it shall be the Contractor's responsibility to have a licensed land surveyor establish the right-of-way line where it is not apparent.

1.02 PROTECTION AND RESTORATION

A. All existing features and improvements to or on easements shall be restored by the Contractor equivalent to those existing prior to construction at no additional cost to the Owner. Compliance with special requirements or considerations indicated on the Drawings for the use of easements shall be the Contractor's responsibility at no additional cost to the Owner.

B. Trees within construction easement shall be preserved to maximum practical extent, unless specifically indicated in the Drawings.

1.03 SPECIAL CONSTRUCTION METHODS

A. Special and hand construction methods may be required to remain within the available easements. Such methods shall be used by the Contractor at no additional cost to the Owner.

B. Other Contractors could be working on related work at or near the site; therefore, the Contractor is expected to cooperate and provide adequate access to all other working parties at or near the site.

1.04 STAGING AREAS

A. Staging area will be provided by the Owner.

1.05 CONSENT FOR ACCESS TO PROPERTY

A. Contractor is responsible for obtaining property owner's written approval as needed to access construction work areas through private property, at no additional costs to the municipality.

B. A suggested "Consent for Access to the Property" form is included at the end of this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED

Consent for Access to the Property (*Suggested Form*)

Name of Property Owner: _____
Property Address: _____
Type of Property: _____

I hereby consent to Employees and authorized Representatives of the municipality, Contractors and their Subcontractors of the municipality, and Consultants of the municipality the right to enter the property and continued access and use of, by, through, and onthe property for the following purposes related to the (*municipality and project title)* Project:

- Documentation and oversight of the project,
- Observations, including, but not limited to, taking notes, recordings, photographs, and surveying,
- Construction related activities,
- Compliance activities,
- Project management and planning activities, and
- Other activities necessary for the planning, construction, implementation, documentation, and finalization of the above-referenced project.

I am the property owner or an individual having the authority or the authorization of the property owner to sign this access agreement. I give this written permission voluntarily with the full knowledge of my right to refuse and without threats or promises of any kind.

Please indicate if you are granting access by signing this document and providing your address, telephone number(s), and email address so that you may be contacted if needed.

☐ YES ☐ NO

Name (Printed): _____

Name (Signature): _____

Date: _____

Address: _____

City: _____ State: _____ Zip: _____

Telephone Number(s):Work: _____ Alternate: _____

Email: _____

Name of Municipality's Representative: _____

Title: _____ Date: _____

END OF SECTION

SECTION 01 21 00

ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedure for administration of Allowances.

1.02 RELATED REQUIREMENTS

A. Individual Technical Specification Sections listed under “Schedule of Allowances” at the end of this Section.

1.03 ALLOWANCE

A. The Allowance is a sum of money included in the Contract Price to cover the cost of a service, all inclusive, to be provided under the Contract by a party other than the Contractor.

B. The Allowance is included in the Bid Form.

C. The sum of an Allowance is an estimated amount.

D. The Contractor will be reimbursed only for the costs invoiced by the party providing the service, and no mark up, such as overhead and profit shall be charged by the Contractor.

E. Services may be less than, equal to, or greater than, the estimated Allowance amount. Contractor will be paid only the actual cost of the services.

1.04 ADJUSTMENT OF BONDS AND INSURANCE

A. Adjustment to Contractor’s bonds and insurance on account of adjustment to Allowance will only be dealt with in the final Pay Application considering the final cost of the project in comparison to the Bid Price.

1.05 SCHEDULE

A. A Schedule of Allowances for this Contract is included at the end of this Section.

1.06 ENGINEER RESPONSIBILITIES

A. Consult with Contractor in consideration of supplier of services.

1.07 CONTRACTOR RESPONSIBILITIES

A. Execute purchase agreement with designated supplier.

B. For additional information, refer to specific Specification Sections referenced in Schedule of Allowances.

1.08 PAYMENT PROCEDURES

A. Payment will be made under the Bid Item for the specified Allowance.

B. Contractor submit invoices on a monthly basis with Pay Application.

C. Pay Application will not be accepted without invoices for Allowance services performed during the Pay Application pay period.

D. Pay invoice on approval of Engineer.

1.09 SCHEDULE OF ALLOWANCES

A. Relocation of Underground Utilities: Allow the amount of $82,000. For additional information, see Section 01 14 02 – Utility Obstructions and Bid Form.

B. Testing Allowance: Allow the amount of $41,000. For additional information, see Section 01 45 23 – Testing Laboratory Services and Bid Form.

C. Electrical Service Allowance: Allow the amount of $15,000. For additional information, see Section 26 27 10 – Electrical Service and Bid Form.

D. Pre-authorized Changes During Construction Allowance: Allow the amount of $100,000. For additional information, see Standard General Conditions of the Construction Contract, Paragraph 11.05.D – Owner-Authorized Changes in the Work (as amended by Supplementary Conditions SC-11.05.D), Paragraph 13.02.C – Owner's Contingency Allowance, and the Bid Form. Changes to Work are governed under the Change Order provisions of the Contract Documents. If the cumulative price of Changes to Work total less than the Pre-authorized Changes During Construction Allowance, the Contract Price will be adjusted under Article 13 of the Standard General Conditions of the Construction Contract. For all Changes to Work in excess of the Allowance amount, the Contract Price will be adjusted under Article 11 of the Standard General Conditions of the Construction Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. For the purposes of this Specification Section, the terms “material and equipment” and “Products” have the same meaning and are used interchangeably.

1.02 RELATED REQUIREMENTS

A. Conditions of the Contract

1.03 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Contractor’s Options:
1. For Products specified only by reference standard, select any product meeting that standard.
2. For Products specified by naming several products or manufacturers, select any one of the products or manufacturers named, which complies with the specifications.
3. For Products specified by naming one or more Products or manufacturers and “or equal”, “or Engineer approved equivalent”, or “Engineer reviewed equivalent”, or similar term, Contractor shall submit a request as for substitutions for any Product or manufacturer not specifically named. The use of brand names is for the purpose of describing the standard of quality, performance and characteristics desired, and is not intended to limit or restrict competition.
4. For Products specified by naming only one Product and manufacturer, there is no option. This is usually done in cases where the Owner has standardized on previously purchased products and spare parts at its facilities, and needs to maintain consistent training, operation, and maintenance programs.

B. Substitutions:
1. For a period of 30 days after the Preconstruction Conference, Engineer will consider written requests from Contractor for substitution of Products.
2. Submit a separate request for each Product, supported with complete data, with drawings and samples as appropriate, including:
   a. Comparison of the qualities of the proposed substitution with that specified.
   b. Changes required in other elements of the work because of the substitution.
   c. Effect on the construction schedule.
   d. Cost data comparing the proposed substitution with the Product specified.
   e. Any required license fees or royalties.

f. Availability of maintenance service, and source of replacement materials.

3. Engineer shall be the judge of the acceptability of the proposed Product substitution.

C. Contractor's Representation:

1. A request for a Product substitution constitutes a representation that Contractor:
   a. Has investigated the proposed Product and determined that it is equal to or superior in all respects to that specified.
   b. Will provide the same warranties or bonds for the substitution as for the Product specified.
   c. Will coordinate the installation of an accepted substitution into the Work, and make such other changes as may be required to make the Work complete in all respects. Upon request, submit to Engineer to-scale dimensioned electronic drawing files of the specific model of the requested substituted equipment items. Drawings shall show general arrangement plan and sections. Drawing files shall be in AutoCAD dwg format.
   d. Waives all claims for additional costs or contract time, under his responsibility, which may subsequently become apparent.

D. Engineer will review requests for substitutions with reasonable promptness, and notify Contractor, in writing, of the decision to accept or reject the requested substitution.

1.04 INTENT OF TECHNICAL SPECIFICATIONS

A. Since the specified materials and details of equipment and component fabrication and assembly are given for specific functional, operational, maintainability, and compatibility reasons, which are not detailed in the Contract Documents, any substitution shall provide the functional intent as well as the specified intent in all details, as determined by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00

PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Measurement and Payment

B. Schedule of Values

C. Application for Payment

1.02 ADDITIONAL REQUIREMENTS

A. Agreement and corresponding Bid.

B. Conditions of the Contract: Progress payments and final payments.

1.03 MEASUREMENT AND PAYMENT

A. Unit Price Items:
   1. Estimated Quantities:
      a. Estimated quantities in Bid Form are approximate and used only for:
         1) Basis for estimating probable cost of Work.
         2) Comparison of Bids submitted for Work.
      b. Actual Work done or materials furnished under Unit Price item may differ from estimated quantities.
      c. Basis of payment: Actual amount of Work as determined by applying the appropriate Unit Price as Bid.
   2. Water Line, Effluent Line, or Sewage Force Main in Place:
      a. Unit Price per lineal foot for each item of Work to include all costs, unless otherwise specified.
      b. Includes all trenching, backfilling, compaction, testing, and disinfection.
      c. No payment for disinfection portion of the Work until successful submittal of Certification of Disinfection of Water Facilities as specified in Section 33 13 13 – Disinfection of Domestic Water Systems.
      d. Includes all fittings required for the Work, whether or not shown, except valves.
      e. No extra payment for dewatering, rock excavation, select backfill, shoring, bracing or other attendant work, unless specifically provided in the Bid Schedule.

3. Trenching and Backfilling:
    a. Unit Price Bid per lineal foot for each item of Work to include all costs, unless otherwise specified.
    b. All Trenching Unclassified: The Bid Unit Price applies equally for any conditions encountered and any obstructions encountered for which separate Bid Items are not included in the Contract.
    c. Depth of Trench: Height between existing ground surface and invert of pipe based on survey cut sheets.
    d. No progress payments for lengths of trench that have not been backfilled as specified.
    e. No extra payment will be made for dewatering, rock excavation, sheeting, shoring, bracing or other attendant work, unless specifically provided in the Bid Schedule.
    f. No payment for trenching and backfilling until corresponding pipe in place is acceptable and pipe detection systems are in place and successfully tested.
4. Furnish and Install Sewer Line:
    a. Measured for payment after installation.
    b. Length measurement to begin and end at:
        1) End of pipe where not connected to other pipe, fitting, or manhole.
        2) Centerline of manholes.
        3) Where otherwise indicated on the Drawings.
    c. No extra payment will be made for breakage.
    d. No payment for pipe until corresponding trenching and backfilling is acceptable.
    e. Unit Price per lineal foot includes all fittings required for the Work, whether or not shown on Drawings.
5. Manholes and Drop Manholes:
    a. Lump sum amount for various ranges in depth of shallow, standard and drop manholes, complete in place and ready for use.
    b. Manhole depth measurement: Height between manhole invert and top of manhole cover.
6. Connection to Existing Manhole:
    a. Connections: Lump sum amount.
    b. Payment to include all necessary work items.
7. Special Bedding or Encasement Where Specifically Indicated on Drawings:
    a. Payment to include all Work and materials and is in addition to amount for trenching and backfilling and for pipeline.
8. Crossing:
    a. Each crossing itemized in the Bid Schedule shall be paid as lump sum amount.
    b. Amount to include all Work or material required for complete ready to use installation.

9. Removal and Replacement:
    a. When itemized in the Bid Schedule, payment to include all work and materials including removal, hauling and disposal, and replacement.
    b. Pavement:
        1) Payment for trench pavement replacement to be to the limits specified in Section 32 09 00 – Removal and Replacement of Existing Surfaces, or as indicated on Drawings.
        2) Payment for pavement replacement required for water service line connections and water meter installations shall be incidental to each connection detail.
    c. Sidewalks:
        1) There will be no additional payment for replacement of sidewalks unless itemized on Bid Schedule.
    d. Gravel Surfaces: There will be no additional payment for replacement of gravel surfaces.
10. Other Unit Price Items:
    a. Unit complete in place and ready for use including all Work.

B. Lump Sum Items: Payment for all lump sum Bid Items includes all Work, labor, and materials required to provide a complete ready to use installation.

C. Materials:
1. Payment for materials delivered but not fully incorporated in project only made if such materials are included in the Schedule of Values and if such materials are available for inspection at Contractor's jobsite yard.
2. For small projects for which a schedule of values is not required, payment for materials delivered but not fully incorporated in the project will only be made if such materials are available for inspection at Contractor's jobsite yard, and for which invoices are presented to Engineer.
3. Payment for materials delivered but not fully incorporated into the project is only allowed if made without any Contractor markup or any other associated fees.

D. Allowance Items: Contractor's actual costs for allowance items listed in Section 01 21 00 – Allowances based on invoices received for actual time and materials expenses.

E. Incidental Work:
1. All Work, labor, materials, appurtenances, activities, and requirements to complete the facilities complete in place and ready for use, and to comply with all requirements and conditions of the Contract Documents are considered incidental Work to the Contract Documents' Bid Items. No separate, additional or special payment will be due the Contractor for incidental Work.
2. Above, on, or below ground obstructions, utilities, features or improvements which interfere with the Work or which must be moved, removed and/or restored to accomplish the Work are considered as incidental Work for which

separate payment will not be made if separate Bid Items or allowances are not specifically given for such in the Contract Documents.

3. Traffic control work, signs, and devices unless otherwise specifically provided in the Bid Schedule.
4. Final adjustment of existing or new manhole rims, water valves, water meter lids, and fire hydrants to new finished grade, unless otherwise specifically provided in the Bid Schedule.
5. Removal and/or replacement of sidewalk, curb and gutter, driveway pavement, medians, gravel surface, and all pavement striping replacement are considered incidental to work.
6. Reclamation seeding.
7. Pipe identification tape and marker posts.
8. Repair of existing water service lines of 1" and smaller.
9. Repair of existing sewer service laterals of 4" and smaller.
10. Television inspection of sewer piping installed under Section 33 31 01 – Sanitary Sewerage Systems.
11. All clearing and disposal costs.
12. Compliance with requirements of storm water discharge permit as specified by USEPA and as specified in these Contract Documents.
13. Preparation of Shop Drawings prior to delivery of materials.

F. Operation and Maintenance Manual: For equipment requiring Operation and Maintenance Manuals, no payment for installation of said equipment will be made to the Contractor until final Operation and Maintenance Manuals have been submitted and accepted by the Engineer.

G. Mobilization, Insurance and Bonds: Bid Item amount is shown on the Bid Form.

H. Demobilization and Submittal of All Closeout Documents: Bid Item is shown on the Bid Form. Fifty percent of Bid Item will not be paid until Contractor has completed all Closeout Submittals to Engineer as specified in Section 01 77 00 – Contract Closeout.

1.04 SCHEDULE OF VALUES

A. Requirements Included:

1. Submit to the Engineer a Schedule of Values allocated to the various portions of the Work, within 15 days after start of Contract Time.
2. Upon request of the Engineer, support the values with data which will substantiate their correctness.
3. The Schedule of Values, unless objected to by the Engineer, shall be used only as the basis for the Contractor's Application for Payment.

B. Form and Content of Schedule of Values:

1. Type Schedule on 8-1/2" x 11" white paper; Contractor's standard forms and automated printout will be considered for approval by Engineer upon Contractor's request. Identify Schedule with:

a. Title of Project and location.
b. Engineer and Project number.
c. Name and address of Contractor.
d. Contract designation.
e. Date of submission.

2. Schedule shall list the installed value of the component parts of the Work in sufficient detail to serve as a basis for computing values for progress payments during construction. Schedule shall include all Work shown on Drawings and indicated in Specifications. Schedule shall be subdivided by categories with subtotals shown for each Bid Item listed in the Bid.
3. Follow the table of contents of this Project Manual as the format for listing component items.
   a. Identify each line item with the number and title of the respective major Section of the Specifications.
   b. List items paid via allowances separately from the rest of the Work and at the end of the Schedule.
4. For each major line item list subvalues of major products or operations under the item.
5. Each of the various portions of the Work (excluding allowance items) listed in the Schedule of Values shall include a directly proportional amount of the Contractor's overhead and profit.
6. The unit values of the materials or equipment for which progress payments will be requested prior to installation and demonstration shall be broken down into:
   a. Cost of the material or equipment, delivered and unloaded at the site, with taxes paid.
   b. Installation costs, including Contractor's overhead and profit.
   c. Shakedown and demonstration of equipment and/or systems.
   d. Operator training and/or manufacturer's inspection and/or certifications if required.
7. The unit quantity for bulk materials shall include an allowance for normal waste.
8. The sum of all values listed in the Schedule shall equal the total amount of Contract.
9. No payment will be made exclusively for Contractor's preparation of Submittals.

1.05 APPLICATIONS FOR PAYMENT

A. Requirements Included:
   1. Submit Applications for Payment to Engineer in accordance with the Schedule established by conditions of the Contract and Agreement between Owner and Contractor.

B. Format and Data Required:
   1. Cover and signature page: As reviewed and approved by Engineer.
   2. Sheet size: 8.5" x 11" or 8.5" x 14".

3. Payment items: Follow approved Schedule of Values.
4. Preparation: Typed or machine printed.
5. Columns Included:
    a. Bid or Payment Item (from Schedule of Values)
    b. Unit
    c. Contract:
        1) Contract or scheduled unit price
        2) Quantity
        3) Total price
    d. Previously Completed:
        1) Quantity
        2) Total price
    e. Completed this Period:
        1) Quantity
        2) Total price
    f. Total to Date:
        1) Quantity
        2) Total price
6. Contractor's standard format can be used if it meets these requirements or is approved by the Engineer.
7. Submit draft Payment Applications electronically in Microsoft "EXCEL" spreadsheet format to Engineer for review. Include all supporting documents in e-mail to Engineer. Note: Payment Applications in PDF format for review purposes are not allowed.

C. Preparation of Application for Each Progress Payment:
1. Application Form:
    a. Fill in required information, including that for Change Orders executed prior to date of submittal of Application.
    b. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.
    c. Execute certification with signature of a responsible officer of Contract firm.
2. Continuation Sheets:
    a. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
    b. Fill in dollar value in each column for each scheduled line item when Work has been performed or products stored.
    c. List each Change Order executed prior to date of submission, at the end of the continuation sheets.
    d. List by Change Order Number and description, as for an original component item of Work.
3. Limits of Payment for partially complete Sewage Force Main or Effluent Line:
    a. Not to exceed 80 percent of Unit Price for sections of line for which trench compaction tests and finish grading of the trench are complete but pressure testing has not been successfully completed.

D. Substantiating Data for Progress Payments:
   1. Submit with each copy of Application:
      a. Properly identified invoices supporting requests for materials payments.
      b. Properly identified invoices for inspection testing allowance payments.
      c. Labor standards certificate in accordance with example form to be provided by Engineer.
      d. If required by Engineer, Certificate of Payment of all suppliers and subcontractors for which payment has previously been received from Owner, in accordance with example form to be provided by Engineer.
      e. Copy of Construction Schedule showing progress to date.

E. Preparation of Application for Final Payment:
   1. Fill in Application form as specified for progress payments.
   2. Provide Certificate of Payment of all suppliers and subcontractors.
   3. Provide Release of Lien Certificates from all subcontractors.

F. Submittal Procedure:
   1. Review quantities and obtain concurrence of Engineer's field representative before submission.
   2. Submit Applications for Payment to Engineer at the times stipulated in the Agreement.
   3. Number: Seven printed copies of each final, executed application, unless otherwise agreed to at the Pre-Construction Conference.
   4. When Engineer finds Application properly completed and correct, he will transmit Certificate for Payment to Owner, with copy to Contractor.

PART 2 PRODUCT (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 19

PROJECT MEETINGS

PART 1 GENERAL

1.01 MEETINGS

A. Contractor to attend at no additional cost to Owner.

B. Preconstruction conference to be scheduled by Engineer.

C. Monthly progress meetings.

D. Special meetings as deemed necessary and scheduled by Owner or Engineer.

E. Special and final inspections by Owner or Engineer when requested.

F. Contractor responsible for preparing progress meeting agenda and distribution of meeting notes at no additional cost to Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 13

CONSTRUCTION SCHEDULES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Promptly after award of the Contract, prepare and submit to Engineer estimated initial baseline construction progress schedules for the Work.

B. Submit revised progress schedules.

C. Schedule subject to approval of Engineer.

D. Schedule construction working hours.

1.02 FORM OF SCHEDULES

A. Basis of Schedule: Critical path network analysis of construction activities.

B. Format of Graphic Display of Schedule Submitted to Engineer:
1. Gantt horizontal bar chart as a printed copy or in pdf electronic file format, as specified herein.
2. Horizontal Time Scale: Identify the first work day of each week.
3. Provide separate horizontal bar for each activity. In general, subdivide activities into sub-activities having durations no more than 15 working days, so that progress can be easily tracked.
4. List the activities in chronological order according to the start date of each activity.
5. Indicate durations and start/stop dates for each activity.
6. Indicate the predecessor and successor activities for each activity.
7. Identify which activities are on the critical path.

1.03 CONTENT OF SCHEDULES

A. Activities: Show the complete sequence of construction by activity.
1. Include activities for:
   a. Preparation of submittals for major equipment items.
   b. Procurement of major equipment items.
   c. Mobilization.
   d. Preparation of operation and maintenance manuals for major equipment items.
   e. Shakedown/startup testing.
   f. Punchlist work.
   g. Preparation of closeout documents.

h. Any sequence or scheduling constraints specified in Section 01 12 16 – Sequence of Work.

B. Milestones: Indicate milestone dates for:
1. Notice to Proceed.
2. Notice of Substantial Completion.
3. Final Completion.

1.04 PROGRESS REVISIONS

A. Indicate effective date of revision and show progress of each activity to date of submission.

B. Show changes occurring since previous submission of schedule:
1. Major changes in scope.
2. Activities modified since previous submission.
   a. Revised projections of progress and completion.
   b. Revised critical path activities.
   c. Other identifiable changes.

C. Provide a narrative report as needed to define:
1. Problem areas, anticipated delays, and the impact on the schedule.
2. Corrective action to be taken.

1.05 SUBMISSIONS

A. Submit initial baseline schedules within fifteen (15) days after start of Contract Time.
1. Engineer will review schedules and return review comments within 10 days after receipt.
2. If required, resubmit within 7 days after return of review copy.

B. Submit updated schedules to show actual progress of Work with each application for payment: Section 01 29 00 – Payment Procedures.

C. Submit revised progress schedules when requested by Engineer or whenever project is more than 5% behind approved schedule as determined by monthly request for payment.

1.06 DISTRIBUTION

A. Distribute copies of the initial baseline and monthly updated schedules as follows:
1. Engineer's Review Copy: One (1) printed copy or electronic file in .pdf format.
2. Engineer's Record Copy: Four (4) printed copies.

1.07 CONSTRUCTION WORKING HOURS SCHEDULING

A. Notify Engineer at least 48 hours in advance of any work to be done outside of usual working hours or any change in usual working hours.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 23

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop Drawings.

B. Product Data.

C. Samples.

D. Contractor Responsibility.

E. Engineer Responsibility.

F. Schedule of Submittals.

1.02 RELATED WORK/REQUIREMENTS SPECIFIED ELSEWHERE

A. Conditions of the Contract: Definitions and Additional Responsibilities of Parties.

1.03 SHOP DRAWINGS

A. Present Drawings in a clear and thorough manner.
   1. Sufficient detail to show kind, size, and arrangement and function of component materials and devices.

B. Minimum sheet size: 8-1/2” x 11”.

1.04 PRODUCT DATA

A. Preparation:
   1. Provide information required in individual Sections.
   2. Where sheets are reproduced from a pamphlet, catalog, or similar publication, print the manufacturer’s name and the title of the publication on each sheet, or set of sheets, if it is not already on the sheet.
   3. Clearly mark each copy to identify applicable products or models by either neatly encircling pertinent data and marking the circle with an arrow or by crossing out all extraneous data, with black, indelible ink. Do not use highlighter because it will not reproduce well.
   4. For items that may be installed at multiple locations throughout the project, such as pipe materials, valves, other pipe appurtenances, and field coatings, indicate in a cover letter where each item is intended to be installed.
   5. Show performance characteristics and capacities.
   6. Show dimensions and clearances required.

7. Indicate weights of major components.
8. Indicate materials of construction.
9. Do not prepare submittal materials from facsimile (FAX) copies of product data unless specifically authorized by Engineer.

Material described on Drawings but not shown in the Specifications: Provide cut sheets as a minimum, or as called for on the Drawings.

B. Installation data for all materials and equipment for which operation and maintenance manuals will not be provided. Also provide installation data with shop drawing prior to delivery of equipment, if specified in the equipment Section.
1. Provide manufacturer's installation instructions and recommendations.
2. Provide referenced standards for installation.

C. Manufacturer's standard schematic drawings, diagrams, descriptions and information:
1. Modify to delete information that does not apply to Work.
2. Supplement to provide information specifically applicable to the Work.

1.05 SAMPLES

A. Samples shall be of sufficient size and quantity to clearly illustrate:
1. Functional characteristics of the project, with integrally related parts and attachment devices.
2. Full range of color, texture, and pattern.

B. Include identification on each sample, with full project information.

1.06 CONTRACTOR RESPONSIBILITIES

A. If substitutions of materials are proposed, conform to Section 01 25 00 – Substitution Procedures.

B. Submit exactly the required quantity of materials.

C. Review Shop Drawings, Product Data, Certificates, Electrical Schematics, Electrical Connection Diagrams, Test Reports, Installation Instructions, Samples, and similar required submittal materials for completeness and accuracy prior to submission. Return unsatisfactory submittal materials to the supplier or manufacturer for correction.

D. Determine and Verify:
1. Field measurements.
2. Field construction criteria.
3. Catalog numbers and similar data.
4. Conformance with Specifications.
5. Conflicts with other items of construction past, present, or future.
6. Submittal materials are legible.

E. Coordinate each submittal with requirements of the Work and of the Contract Documents.

F. Notify the Engineer in writing, at time of submission, of any deviations in submittal from Contract requirements.

G. Begin no fabrication or work that requires submittals until return of submittals with Engineer's final review.

1.07 SUBMITTAL PROCEDURES

A. Make submittals promptly and in such sequence as to cause no delay in the Work.

B. Execute and attach “Contractor Submittal Form” to each submittal. Sample form is attached to the end of this Section. Sign, date, and forward the Form and the Contractor reviewed submittal materials to the Engineer.

C. Number submittals by respective section number followed by an “S” for submittals, “P” for preliminary O&M, and “F” for final O&M.

D. Include a copy of the respective Specification Section(s). For each paragraph of the Specifications, confirm that the submittal complies and include a tab and sheet number where the information can be found for each paragraph of the Specification. If the submittal does not comply with a paragraph, identify as such and provide an explanation why it does not. If this information is not provided with each submittal and preliminary O&M, then the Engineer will return as “Not Reviewed.” Final O&Ms are excluded from this requirement.

1.08 RESUBMISSION REQUIREMENTS

A. Make corrections/changes in the submittals to comply with comments made by the Engineer and resubmit until final review.
   1. Attach Engineer’s comments from previous submittal annotated with action taken in the current submittal.

B. Number resubmittals as identified in paragraph entitled “Submittal Procedures,” and follow with a numeric value which identifies the number of resubmittals pertaining to that specific submittal.

C. Shop Drawings and Product Data:
   1. Revise initial drawings or data, and resubmit as specified for the initial submittal.
   2. Indicate any changes that have been made other than those requested by the Engineer.

D. Samples: Submit new samples as required for initial submittal.

E. Specifically direct attention in writing to revisions other than the corrections called for by the Engineer on previous submittals.

F. Include a copy of previous “Contractor Submittal Forms.”

G. Include a copy of previous Engineer's comments, marked to show Contractor's responses. If not provided, submittal will be returned as "Rejected/Resubmit."

H. Furnish all applicable information in the resubmittal, including information on material that was favorably reviewed. Upon request, the Engineer will return all but one of the original submittals for reuse by the Contractor.

I. Partial resubmittals are allowed, but following favorable review of the partial resubmittal, provide complete resubmittals including all favorably reviewed material.

1.09 DISTRIBUTION

A. Copy and distribute submittals returned by Engineer marked "No Exception Taken" or "Make Corrections Noted":
1. Job site file.
2. Job site record documents file.
3. Subcontractors and suppliers as appropriate.

B. If returned by Engineer, distribute samples marked "No Exception Taken" or "Make Corrections Noted" as directed by the Engineer.

1.10 ENGINEER RESPONSIBILITIES

A. Review submittals with reasonable promptness as specified herein in the Timeliness subsection.

B. Return submittals with completed Contractor Submittal Form with signature and attach review comments if needed.

C. Return one copy of submittal to Contractor.

D. Submittal Review Status Categories:
1. "NO EXCEPTION TAKEN" – Reviewed for general conformity to the requirements of the Contract Documents. Quantities shown not verified. Contractor's full responsibility is in no way relieved by this action.
2. "MAKE CORRECTIONS NOTED" – Reviewed and noted for general conformity to requirements of the Contract Documents. Quantities shown not verified. Contractor's responsibility is in no way relieved by this action. Resubmittal is not required, provided Contractor concurs with, accepts, and complies with A/E's comments.
3. "REVISE & RESUBMIT" – Reviewed and not accepted. Provide missing information, make corrections as noted, and resubmit full submittal.
4. "REJECTED/RESUBMIT" – Reviewed or partially reviewed and not accepted. Resubmit information in conformance with the Contract Documents.
5. "RECEIPT ACKNOWLEDGED" – Submittal for Section is not required or submittal is being held by A/E for coordination of work with that of another Section.

E. Return submittals with only cursory review and marked “Revise & Resubmit” or “Rejected/Resubmit” when:
   1. It becomes apparent the submittal is not acceptable,
   2. The submittal has not been thoroughly reviewed by the Contractor,
   3. Submittal does not cover all of a Section,
   4. Submittal improperly contains information for more than one Section, or
   5. Submittal is illegible.

F. Return resubmittals only containing partial information.

G. Discard submittal copies in excess of those scheduled.

1.11 LIMITS OF ENGINEER’S RESPONSIBILITY

A. Engineer’s review does not constitute acceptance or responsibility for accuracy of dimensions or quantities.

B. Engineer’s review does not relieve the Contractor from meeting requirements of the Contract Documents.

C. Engineer’s review does not constitute approval for any deviation from the Contract Documents unless such deviations are specifically stated as such on the submittal and specifically allowed by the Engineer by specific written notification for each such variation.

D. Engineer’s review does not relieve the Contractor from responsibility for errors or omissions in the Shop Drawings or from responsibility for having complied with the Contractor’s Responsibilities portion of this Section.

E. Engineer’s review will be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction or to safety precautions or programs incident thereto. The review of a separate item as such will not indicate approval of the assembly in which the item functions.

1.12 PAYMENT AND TIME FOR REVIEW OF EXCESSIVE SUBMITTALS

A. Submittals after first resubmittal:
   1. Owner will charge Contractor for all of Engineer’s review time and costs at Engineer’s standard billing rates through a credit by Change Order.
   2. Reviewed by Engineer at convenience of the Engineer.

1.13 FORMAT

A. Furnish individual submittal packages for each Section. Include a separate Contractor Submittal Form for each Section.

B. The Contractor may elect to make a single submittal for all Sections supplied by a single manufacturer/supplier. Such single submittal must conform to the following:
   1. Index the submittal with tabs with one and only one Section under a single tab.
   2. Include a separate Contractor Submittal Form for each Section.
   3. Identify submittal packages on the front or on the first page with the Owner's name, the project name, the Contractor's name, the subcontractor's name, the date, and the contents of the binder, including the Specification Section(s), title(s), and number(s).

C. Minimum Acceptable Binding Methods:
   1. Submittals of no more than six sheets per set, including cover sheets: Staple in sets.
   2. Submittals of seven to 25 sheets per set: Punch sheets and assemble in a soft-cover binder with 3-hole metal fold-down clips to hold pages or in a ring binder.
   3. Submittals of 26 to 75 sheets: Punch sheets and assemble in a hard-cover ring binder.
   4. Submittals of more than 75 sheets: Punch sheets and assemble in a hard-cover D-ring binder.
   5. Fold 11" x 17" drawings to fit into bound sets of submittals.
   6. Furnish drawings larger than 11" x 17" folded and inserted in pockets in the binders. Provide a complete index in the submittal literature set.

1.14 TIMELINESS

A. As a minimum, the Contractor shall allow the following number of calendar days for submittal process:

	Engineer's Review Time
Initial Submittal	14
Resubmittal	7
Operation and Maintenance Manuals	16

   1. Engineer's Review Time is the time the submittal is in the Engineer's office.
   2. The Engineer will process first those items with higher priority based on a written request from the Contractor.

B. Turnaround time for complex submittals (such as process equipment systems with multiple components, mechanical systems, electrical equipment, instrumentation control systems, and electrical process and instrumentation drawings) may exceed the total indicated in Paragraph 1.14A.

C. Materials, equipment, supplies, or labor to install such materials or equipment for which submittals have not been marked "No Exception Taken" or "Make Corrections Noted" are not eligible for payment and such materials and equipment shall not be allowed on the job site.

1.15 PROJECT RECORD DOCUMENTS

A. If the equipment installed deviates in any way from the submittal for the equipment, then submit copies of submittals that are corrected to show actual equipment supplied.

1.16 ATTACHMENTS TO THIS SECTION

A. Contractor Submittal Form.

1.17 REQUIRED SUBMITTALS

A. Quantity, submit in **one** of the following formats:
   1. Electronic Format:
      a. Submittals in electronic searchable .pdf format are allowed.
      b. Engineer's submittal review will be returned to Contractor in electronic format.
      c. After an electronic submittal is accepted by the Engineer as final, submit one printed copy to Engineer to retain for field use.
      d. Any additional printed copies received will be discarded by Engineer.
      e. Refer to Section 01 78 39 – Project Record Documents for submittal of one printed record set of submittals at Contract close-out.
   2. Or Printed Format:
      a. For submittals in printed format only, submit five copies. Engineer will retain four copies.
      b. Engineer will return one copy to Contractor.
      c. Any additional copies received will be discarded by Engineer.

B. See individual Specification Sections for description of required submittals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

#	CONTRACTOR SUBMITTAL FORM	
Specification No. / Title/Description:	Project:	Contractor's Submittal No.: Date: Product Description:
	CONTRACTOR:	Dates of any previous submissions:
	Subcontractor / Supplier: Specification No.:	Manufacturer: Drawing Nos.:
	Are there any deviations to the Contract Documents? ☐ No ☐ Yes (Explain and Identify:) _____ *Undisclosed deviations/modifications do not relieve the Contractor from the obligation to provide the specified product and detail of installation, and may be cause for rejection of the Work. Deviations and modifications must be listed here or in a separate Request for Substitution.*	

CONTRACTOR'S CERTIFICATION: This submittal has been reviewed by the Contractor in compliance with Submittal Procedures of the CONTRACT DOCUMENTS' SPECIFICATIONS. Any deviations or substitutions to the CONTRACT DOCUMENTS have been identified above and submitted in compliance with the CONTRACT DOCUMENTS.

If this is a re-submittal, identify on a sheet(s) attached to this form all responses to comments on the previous submittal and all changes other than those specifically requested by the A/E on the previous submittal.

Signed _____ Date:

A/E'S REVIEW RESPONSE

(*Refer to Submittal Specification for explanation of categories.*)

Date Received:	No. Copies Received:
☐ **NO EXCEPTION TAKEN**	
☐ **MAKE CORRECTIONS NOTED**	
☐ **REVISE & RESUBMIT**	
☐ **REJECTED/RESUBMIT**	
☐ **RECEIPT ACKNOWLEDGED**	
By:	Date:
Date Returned:	No. Copies Returned:
A/E'S COMMENTS, IF ANY:	
A/E'S ATTACHMENTS, IF ANY:	

Note: DO NOT combine items from different specification sections into one submittal unless called for in the Section. If provisions in the "General Conditions" conflict with this form, the provisions as stated in the "General Conditions" shall prevail.

MOLZENCORBIN
ENGINEERS | ARCHITECTS | PLANNERS
2701 Miles Road SE, Albuquerque, NM 87106

SECTION 01 42 13

ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 SPECIAL

A. A/E – Architect/Engineer.

B. EPA – United States Environmental Protection Agency.

C. NMAC – New Mexico Administrative Code.

D. NMED – New Mexico Environment Department.

E. NMSA – New Mexico Statutes Annotated.

F. OSE – Office of State Engineer.

G. OSHA – Occupational Safety and Health Administration.

1.02 OTHER

A. As indicated on the Drawings, as apparent from the Drawings, or in accordance with standard practice.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Abbreviations and acronyms used in Contract Documents to identify reference standards.

1.02 QUALITY ASSURANCE

A. Application: When a standard is specified by reference, comply with requirements and recommendations stated in that standard, except when requirements are modified by the Contract Documents, or applicable codes establish stricter standards.

B. Publication Date: The publication in effect on the date of bid, except when a specific publication date is specified.

1.03 ABBREVIATIONS, NAMES, AND ADDRESSES OF ORGANIZATIONS

A. Obtain copies of referenced standards direct from publication source, when needed for proper performance of Work, or when required for submittal by Contract Documents.

AA	Aluminum Association 818 Connecticut Avenue, NW Washington, D.C. 20006
AASHTO	American Association of State Highway and Transportation Officials 444 North Capital Street, NW Washington, DC 20001
ABMA	American Bearing Manufacturers Association (formerly Anti-friction Bearing Manufacturers Association) 2025 M. Street, NW, Suite 800 Washington, DC 20036-3309
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219

ADAAG	Americans with Disabilities Accessibility Act Guidelines www.access-board.gov/adaag
ADC	Air Diffusion Council 230 North Michigan Avenue Chicago, IL 60601
AGMA	American Gear Manufacturers Association 1001 N. Fairfax Street, Suite 500 Alexandria, VA 22314-1587
AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AISC	American Institute of Steel Construction 1221 Avenue of the Americas New York, NY 10020
AISI	American Iron and Steel Institute 1000 16 Street, NW Washington, DC 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
APWA	American Public Works Association 1313 E. 60th Street Chicago, IL 60637
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 345 East 47 Street New York, NY 10017
ASME	American Society of Mechanical Engineers 345 East 47 Street New York, NY 10017
ASTM	American Society for Testing and Materials International 1916 Race Street Philadelphia, PA 19103

AWI	Architectural Woodwork Institute 1411 S. Rimpau Avenue, Suite 213 Corona, CA 92879-7500
AWWA	American Water Works Association 6666 W. Quincy Avenue Denver, CO 80235
AWS	American Welding Society 2501 NW 7 Street Miami, FL 33125
CBM	Certified Ballast Manufacturers 1422 Euclid Avenue Cleveland, OH 44115
CPSC	Consumer Products Safety Commission www.cpsc.gov
CRSI	Concrete Reinforcing Steel Institute 180 North LaSalle Street, Suite 2110 Chicago, IL 60601
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, Canada M9W 1R3
DHI	Door and Hardware Institute 7711 Old Springhouse Road McLean, VA 22102
EEI	Edison Electric Institute 1111 19 Street, NW Washington, DC 20036
ETL	Electrical Testing Laboratories 2319 Dorris Place Los Angeles, CA 90031
FM	Factory Mutual www.fmglobal.com

FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407 www.fss.gsa.gov/pub/fed-specs.cfm
GA	Gypsum Association 1603 Orrington Avenue Evanston, IL 60201
HI	Hydraulic Institute 6 Campus Drive, First Floor North Parsippany, NJ 07054-4405
IBC	International Building Code published by International Code Council 500 New Jersey Avenue, NW, 6th floor Washington, DC 20001
ICEA	Insulated Cable Engineers Association P.O. Box P South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 345 East 47 Street New York, NY 10017
ISA	Instrument Society of America 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
MIL	Military Specification Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
NACE	National Association of Corrosion Engineers P.O. Box 21830 Houston, TX 77218

NEC	National Electric Code Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NEMA	National Electrical Manufacturers' Association 2101 L Street, NW Washington, DC 20037
NESC	National Electric Safety Code 345 East 47 Street New York, NY 10017
NFPA	National Fire Protection Association 470 Atlantic Avenue Boston, MA 02210
NFPA	National Forest Products Association 1619 Massachusetts Avenue, NW Washington, DC 30036
NMBC	New Mexico Building Code Code Regulations Licensing Department Construction Industries Divisions 725 St. Michaels Drive Santa Fe, NM 87504
NRCA	National Roofing Contractors Association www.nrca.net
NSF	National Sanitation Foundation International P.O. Box 130140 789 N. Dixboro Road Ann Arbor, MI 48105
NWWDA	National Wood Window and Door Association P.O. Box 34518 Memphis, TN 38184
OSHA	Occupational Safety & Health Administration www.osha.gov
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 20076

PCI	Prestressed Concrete Institute 20 North Wacker Drive Chicago, IL 60606
SDI	Steel Door Institute 712 Lakewood Center North Cleveland, OH 44107
SIGMA	Sealed Insulating Glass Manufacturer's Association 111 East Wacker Drive Chicago, IL 60601
SJI	Steel Joist Institute 1703 Parham Road Suite 204 Richmond, VA 23229
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc. 8224 Old Court House Road Vienna, VA 22180
SSPC	The Society for Protective Coatings (formerly Steel Structure Painting Council) 40 24th Street, 6th Floor Pittsburgh, PA 15222-4656 (877) 281-7772
UBC	Uniform Building Code International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601-2298
UL	Underwriters' Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062
UPC	Uniform Plumbing Code International Association of Plumbing/Mechanical Officials 20001 Walnut Drive, South Walnut, CA 91789-2825

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 16.14

DIGITAL VIDEO RECORDING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Digital video record entire area affected by construction prior to construction.

B. Perform additional digital video recording during project as directed by Engineer.

C. Have digital video files available with viewing facilities for viewing by Engineer, Owner, and Contractor when requested.

D. Digital video recording requirement part of Contractor's general overhead for which separate payment shall not be made.

1.02 EQUIPMENT REQUIREMENTS

A. Digital Video Camera Equipment:
1. Recording Media: DVD.
2. Format: Digital files compatible with standard playback equipment, and as agreed upon beforehand with Owner.
3. Color picture.
4. Audio, clear narration in English of significant features observed during recording.
5. Zoom lens.
6. Indexing of locations on discs for easy reference.
7. File downloading capability: To a personal computer (PC) that operates on Microsoft operating system of Windows 11 or higher.

B. Video Viewing System:
1. Screen: 26 inches (diagonal dimension) or greater.
2. Color picture.
3. Audio.
4. Indexing of locations on discs for easy reference.
5. Slow motion.
6. Stop frame for viewing single picture.
7. Reversing.
8. Compatible with digital recording equipment.

C. Discs:
1. Catalogued, cross-referenced, indexed.

1.03 SYSTEM OPERATOR REQUIREMENTS

A. Familiar and experienced with equipment and equipment operations.

1.04 AVAILABILITY

A. Recording equipment and operator available on-site within 0.5 hours of Engineer's request during Contractor's normal working hours if scheduled.

B. Viewing system and appropriate discs available at meetings as scheduled or when requested by Engineer.

C. Deliver one (1) complete set of files to the Owner upon acceptance by the Engineer.

1.05 DIGITAL VIDEO RECORDING REQUIRED IF SCHEDULED

A. All streets, alleys, curbs, culverts, vaults, manholes, areas, locations where construction will be done:
   1. Both directions along utility line or street to be constructed or reconstructed.
   2. Maximum speed of camera movement 4 feet per second.
   3. Lateral and close-up view of any features or facilities that may be affected by construction.
   4. Not more than 14 calendar days prior to actual construction.
   5. Include data documentation on disc.
   6. Audio explanation of significant features observed during recording.
   7. Recording results acceptable to Engineer.
   8. Special documentation if requested by Engineer.

B. Drainage Documentation:
   1. Following general rainfall over area.
   2. Prior to any construction if practical.
   3. All areas where work will be performed.
   4. Recorded to document general preconstruction drainage patterns, problems, street surface conditions, and related items.
   5. On request of Engineer.

1.06 SCHEDULE OF REQUIRED DIGITAL VIDEO RECORDING

A. Provide digital video recording as outlined in Part 1.05 A.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 23

TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Employ and pay for the services of an independent testing laboratory to perform specified services and testing associated with soil gradation and density, concrete, and asphalt.

1.02 ADDITIONAL REQUIREMENTS

A. Conditions of the Contract: Testing required by laws, ordinances, rules, regulations, orders or approval of public authorities.

B. Each specification section listed: Laboratory tests required and standards for testing.

1.03 SUBMITTALS

A. Submit for Engineer's review the name of proposed Laboratory to perform required testing and their statement of qualifications.
   1. Name(s) of professional engineer(s) registered in the state in which the project is located who will be signing test results.
   2. Qualifications of technicians and their certifications, such as NICET (National Institute for Certification in Engineering Technologies), to perform testing required for this project as specified in ASTM E329.
   3. Evidence of current participation in the AASHTO Materials Reference Laboratory (AMRL) program, and accreditation of the laboratory and list of test methods currently accredited by the AASHTO Accreditation Program (AAP).

1.04 QUALIFICATION OF LABORATORY

A. Meet basic requirements of ASTM E329, "Standard Specification Agencies Engaged in Testing and/or Inspection of Materials Used in Construction".

B. Authorized to operate in the State in which the Project is located by the local governing authority for the AASHTO Accreditation Program.

C. Testing Equipment:
   1. Calibrated at reasonable intervals by devices of accuracy traceable to either:
      a. National Institute of Standards and Technology (NIST) (formerly National Bureau of Standards).
      b. Accepted values of natural physical constants.

D. Office Location: The location at which specified services and testing will be performed or from which Testing Laboratory staff will mobilize to perform field work shall be within 50 miles of the project site.

1.05 LABORATORY DUTIES

A. Cooperate with Engineer and Contractor; provide qualified personnel after due notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction:
   1. Comply with specified standards.
   2. Ascertain compliance of materials with requirements of Contract Documents.

C. Promptly notify Engineer and Contractor of observed irregularities or deficiencies of work or products.

D. Promptly submit written report of each test; one copy to Engineer, one copy to Structural Engineer, and copies as required to Contractor. Each report shall include:
   1. Date issued.
   2. Project title and number.
   3. Testing laboratory number, address, and telephone number.
   4. Name and signature of laboratory technician.
   5. Date and time of sampling or field testing.
   6. Record of temperature and weather conditions.
   7. Date of test.
   8. Identification of product and specification section.
   9. Location of sample or test in the Project.
   10. Type of test.
   11. Results of tests and compliance with Contract Documents.
   12. Interpretation of test results when requested by Engineer.

E. Perform additional tests as required by Engineer or the Owner.

F. In all cases, the Engineer shall determine the number, type and location of tests.

G. Provide signature and seal of a Professional Engineer, licensed in the State where work is being performed, and who is employed by the Laboratory on all test results.

1.06 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:
   1. Release, revoke, alter or enlarge on requirements of Contract Documents.
   2. Approve or accept any portion of the Work.
   3. Perform any duties of the Contractor.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel, provide access to Work, and manufacturer's operations.

B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other material mixes which require control by the testing laboratory.

D. Furnish copies of Product test reports as required.

E. Furnish Incidental Labor and Facilities:
   1. To provide access to Work to be tested.
   2. To obtain and handle samples at the Project site or at the source of the product to be tested.
   3. To facilitate tests.
   4. For storage and curing of test samples.

F. Make arrangements with laboratory and pay for additional samples and tests required for Contractor's convenience and retests required for previously failed tests.

G. Notify testing laboratory at least 48-hours in advance of all testing required by job progress or conditions, or the Engineer.

H. Provide on-site facilities as required for initial curing of concrete cylinders.

1.08 PAYMENT

A. An allowance is included in the Bid Proposal to cover field testing performed by an independent testing laboratory. In accordance with Section 01 21 00 - Allowances, the Owner will reimburse the Contractor for the actual cost of all such testing based on invoices received from the laboratory.

B. The invoiced cost of mileage for all vehicles used shall be no greater than the standard mileage rate for business miles in effect at the times of occurrence, as published by the Internal Revenue Service (IRS).

C. The testing allowance stated in the Bid Proposal is an estimated dollar amount. The final dollar amount reimbursed to the Contractor for testing may be less than, equal to, or more than the stated allowance.

D. Actual reasonable sample shipping costs will be paid to the Contractor in the same manner and under the testing allowance.

E. Costs for testing described in Paragraph 1.07.F are not eligible for reimbursement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 51 00

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 WATER

A. Water required for construction may be drawn from the Owner's water system at the current municipal rates for construction use. Coordinate with Owner's representative as to location of water supply point.

B. Contractor is not allowed to sell water to other users.

1.02 ELECTRICITY

A. Contractor's sole responsibility and expense.

1.03 OTHER

A. All other temporary utilities required to accomplish the Work to be the responsibility of and at the Contractor's sole expense.

1.04 RELATED REQUIREMENTS

A. Section 01 52 13 – Field Offices and Sheds

1.05 SPECIAL PROJECT REQUIREMENTS SCHEDULE

A. Provide sanitary facilities for Contractor's personnel. Use of Owner's restrooms by Contractor's personnel will not be permitted.

1.06 CONNECTION REQUIREMENTS

A. Install temporary backflow preventer (provided by Owner for deposit) at hydrant source or point of connection.

B. Install temporary flowmeter (provided by Owner for deposit) at fire hydrant source or point of connection.

C. If loading water into a water truck, provide an air gap of twice the diameter of the fill pipe between the fill pipe the top of the tank inlet port.

D. Provide at no additional cost to Owner.

E. Only Owner's staff may operate fire hydrant.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 52 13

FIELD OFFICES AND SHEDS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install, and maintain storage and work sheds needed for construction and temporary field offices during entire construction period.

B. At completion of Work, remove field offices, sheds, and contents.

1.02 OTHER REQUIREMENTS

A. Prior to installation of offices and sheds, consult with Engineer on location, access, and related facilities.

B. Furnish, install, and maintain temporary electrical, internet, and other services, as needed.

1.03 REQUIREMENTS FOR FACILITIES

A. Construction:
1. Structurally sound, weathertight, with floors raised above ground.
2. Temperature transmission resistance: Compatible with occupancy and storage requirements.
3. At Contractor's option, portable or mobile buildings may be used. Mobile homes, when used, shall be modified for office use.

B. Contractor's Office and Facilities:
1. Size: As required for general use.

C. Storage Sheds:
1. To requirements of various trades.
2. Dimensions: Adequate for storage and handling of products.
3. Ventilation: Comply with specified codes and requirements for products stored.
4. Heating: Adequate to maintain temperatures specified in respective sections for products stored.

D. Office for Engineer's Resident Project Representative:
1. Structure physically separate from Contractor's office.
2. 15 ft. x 8 ft. minimum floor dimensions.
3. Adequate lights, electricity, and thermostat-controlled heating and refrigerated air cooling.

4. Combination copy/file/printer machine with scan capability for 8-1/2” x 11” and 11” x 17” sheets. Contractor shall pay monthly service charge and shall furnish paper and toner cartridges sufficient to copy up to 500 sheets per month.
5. Internet connection capable of fast (minimum of 1.5 Mbps) download of information. The system shall be unlimited in connection use, uninterruptible and continuous until contract completion. The Contractor shall pay for all services associated with this connection/installation.
6. Desk (minimum 4 drawer), four (4) drawer legal size filing cabinet, swivel desk chair, 3 ft. x 5 ft. drafting table, adjustable drafting chair or adjustable stool, and visitor’s chair.
7. Office to be installed at site before any payment made to Contractor and maintained at site until Substantial Completion is reached on all portions of the Work.
8. Locking door with only Engineer to have key.
9. Identified with sign stating:
    a. Molzen Corbin Consulting Engineers:
    b. No hiring done here.
    c. No deliveries made here.
    d. No telephone available.
10. Security of office is Contractor’s responsibility.

1.04 USE OF EXISTING FACILITIES

A. Existing facilities at site shall not be used for field offices or for storage.

1.05 MATERIALS, EQUIPMENT, FURNISHINGS

A. May be new or used, but must be serviceable, adequate for required purpose, and must not violate applicable codes or regulations.

1.06 PREPARATION

A. Fill and grade sites for temporary structures to provide surface drainage.

1.07 INSTALLATION

A. Construct temporary field offices and storage sheds on proper foundations; provide connections for utility services.
    1. Secure portable or mobile buildings when used.
    2. Provide steps and landings at entrance doors.

1.08 MAINTENANCE AND CLEANING

A. Provide periodic maintenance and cleaning for temporary structures, furnishings, equipment, and services.

1.09 REMOVAL

A. Remove temporary field offices, contents, and services when no longer needed.

B. Remove storage sheds when no longer needed.

C. Remove foundations and debris; grade Site to required elevations and clean areas.

1.10 MEASUREMENT AND PAYMENT

A. Field offices and sheds are considered incidental to the Work to be completed. No separate payment shall be made for field offices and sheds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 56 00

BARRIERS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install, and maintain suitable barriers as required to prevent public entry, and to protect the public, Work, and existing facilities; remove when no longer needed or at completion of Work.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Materials may be new or used, suitable for the intended purpose, but must not violate requirements of applicable codes and standards.

2.02 BARRIERS

A. Materials to Contractor's option, as appropriate to serve required purpose.

PART 3 EXECUTION

3.01 GENERAL

A. Install facilities of a neat and reasonable uniform appearance, structurally adequate for required purposes.

B. Maintain barrier during entire construction period.

C. Relocate barriers as required by progress of construction.

D. Provide barriers to protect the public from excavations and hazardous conditions and operations.

E. If a trench or excavation, where accessible to the public, is left open at night or weekends, it must be barricaded with flashing lights.

3.02 FENCES

A. Fence Location:
   1. Locate fence to enclose substantially entire Project site or that portion the Contractor establishes as required to encompass entire Project construction operation.
   2. Locate vehicular entrance gates in suitable relation to construction facilities; and to avoid interference with traffic on public thoroughfares.

B. Chainlink Fence:
   1. Fence not generally required for sewer lines, waterlines, and street work.
   2. Fence generally required for treatment plant, pump stations, and similar facilities.

3.03 REMOVAL

A. Completely remove barricades, including foundations, when construction has progressed to the point that they are no longer needed.

B. Clean and repair damage caused by installation, fill and grade areas of the site to required elevations and slopes, and clean the area.

END OF SECTION

SECTION 01 57 00

TEMPORARY CONTROLS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide and maintain methods, equipment, and temporary construction, as necessary to provide controls over environmental conditions at the construction site and related areas under Contractor's control; remove physical evidence of temporary facilities at completion of Work.

1.02 NOISE CONTROL

A. Limit to practical extent.

B. Limit to normal working hours when practical.

1.03 DUST CONTROL

A. Provide positive methods and apply dust control materials to minimize raising dust from construction operations, and provide positive means to prevent airborne dust from dispersing into the atmosphere.

1.04 WATER CONTROL

A. Provide methods to control surface water to prevent damage to the Project, the site, or adjoining properties.
   1. Control fill, grading and ditching to direct surface drainage away from excavations, pits, tunnels and other construction areas; and to direct drainage to proper runoff.

B. Provide, operate and maintain hydraulic equipment of adequate capacity to control surface water.

C. Dispose of drainage water and dewatering water in a manner to prevent flooding, erosion or other damage to any portion of the site or to adjoining areas. Any public agency or private landowner arrangements, permits, or other approvals required for the discharge of water are the sole responsibility of the Contractor.

1.05 PEST CONTROL

A. As found necessary during construction.

1.06 RODENT CONTROL

A. Provide rodent control as necessary to prevent infestation of construction or storage area.
   1. Employ methods and use materials which will not adversely affect conditions at the site or on adjoining properties.
   2. Should the use of rodenticides be considered necessary, submit an informational copy of the proposed program to Owner with a copy to Engineer. Clearly indicate:
      a. The area or areas to be treated.
      b. The rodenticides to be used, with a copy of the manufacturer's printed instructions.
      c. The pollution preventive measures to be employed.

B. The use of any rodenticide shall be in full accordance with the manufacturer's printed instructions and recommendations and applicable laws and regulations.

1.07 DEBRIS CONTROL

A. Maintain all areas under Contractor's control free of extraneous debris.

B. Initiate and maintain a specific program to prevent accumulation of debris at construction site, storage and parking areas, or along access roads and haul routes.
   1. Provide containers for deposit of debris as specified in Section 01 74 00 – Cleaning and Waste Management.
   2. Prohibit overloading of trucks to prevent spillages on access and haul routes.
      a. Provide periodic inspection of traffic areas to enforce requirements.

C. Schedule periodic collection and disposal of debris as specified in Section 01 74 00 – Cleaning and Waste Management.
   1. Provide additional collections and disposals of debris whenever the periodic schedule is inadequate to prevent accumulation.

1.08 POLLUTION CONTROL

A. Provide methods, means and facilities required to prevent the discharge of hazardous substances from construction operations.

B. Perform emergency measures required to report, contain and transport harmful substance discharges or spills by complying with Federal and State regulations.

C. Take special measures to prevent harmful substances from entering public waters.
   1. Prevent disposal of wastes, effluents, chemicals or other such substances adjacent to streams, or in sanitary or storm sewers.

D. Provide systems for control of atmospheric pollutants.
   1. Prevent toxic concentrations of chemicals.
   2. Prevent harmful dispersal of pollutants into the atmosphere.

1.09 EROSION CONTROL

A. Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   1. Hold the areas of bare soil exposed at one time to a minimum.
   2. Provide temporary control measures such as berms, dikes, drains, straw bales, silt fences, and wattles.

B. Construct fills and waste areas by selective placement to eliminate surface silts or clays which will erode.

C. Periodically inspect earthwork to detect any evidence of the start of erosion, apply corrective measures as required to control erosion.

1.10 SECURITY CONTROL

A. Provide temporary padlocks during construction on gates, hatches, doors, panels, and boxes having hasps. Coordinate with Owner to install specified permanent padlocks at completion of project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 58 13

PROJECT IDENTIFICATION SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install, and maintain project identification sign(s).

B. Remove signs on completion of construction.

C. Allow no other signs to be displayed.

1.02 RELATED REQUIREMENTS

A. Funding agency supplemental conditions may contain additional requirements.

1.03 PROJECT IDENTIFICATION SIGN(S)

A. Painted sign(s) of size, design, lettering, as scheduled.

B. Locate as directed by Engineer.

1.04 QUALITY ASSURANCE

A. Sign Painter: Professional experience in type of work required.

B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

1.05 PAYMENT

A. Incidental to contract, no separate payment.

PART 2 PRODUCTS

2.01 SIGN MATERIALS AND CONSTRUCTION

A. Unless Otherwise Scheduled:
   1. Sign size: 4’ x 8’
   2. Sign material: 0.75 inch thick exterior grade plywood.
   3. Supports: Two, 4” x 4” x 8’ supports, sign bolted to supports.
   4. Color: White background, black lettering.
   5. Lettering: Minimum 2” height.

PART 3 EXECUTION

3.01 MAINTENANCE

A. Maintain signs and supports in a neat, clean condition; repair damages to structure, framing, or sign.

B. Relocate signs if required by progress of the work.

3.02 REMOVAL

A. Remove signs, framing, supports, and foundations at completion of project.

3.03 SCHEDULE

A. Sign layout to be provided at start of construction.

END OF SECTION

SECTION 01 66 01

PRODUCT DELIVERY, STORAGE, AND HANDLING REQUIREMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. For the purposes of this Specification Section, the terms “Material and Equipment” and “Products” have the same meaning and are used interchangeably.

B. Material and equipment incorporated into the Work:
   1. New and free of defect unless otherwise shown on the Drawings.
   2. Conform to applicable Specifications and standards.
   3. Comply with size, make, type and quality specified, or as specifically approved in writing by the Engineer.
   4. Manufactured and Fabricated Products:
      a. Design, fabricate and assemble in accordance with the best engineering and shop practices.
      b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
      c. Two or more items of the same kind shall be identical, by the same manufacturer.
      d. Products shall be suitable for service conditions.
      e. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.
   5. Do not use material or equipment for any purpose other than that for which it is designed or is specified.

1.02 REUSE OF EXISTING MATERIAL

A. Except as specifically indicated or specified, materials and equipment removed from the existing structure shall not be used in the completed Work.

B. For material and equipment specifically indicated or specified to be reused in the Work:
   1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
   2. Arrange for transportation, storage, and handling of products which require off-site storage, restoration or renovation. Perform such work at no additional cost to Owner.

1.03 MANUFACTURER’S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer’s printed instructions, such instructions shall be included with:
   1. Shop Drawing and/or product data submitted if an Operation and Maintenance Manual is not required, or if specified in the Shop Drawing subsection of the equipment Section.
   2. Operation and maintenance data if required.

B. Handle, install, connect, clean, condition, and adjust products in strict accordance with such instructions and in conformity with specified requirements.
   1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer for further instructions.
   2. Do not proceed with work without clear instructions.

C. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

1.04 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with Construction Schedules, coordinate to avoid conflict with work and conditions at the site.
   1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
   2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved Submittals, and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.05 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible.
   1. Store products subject to damage by the elements in weathertight enclosures.
   2. Maintain temperature and humidity within the ranges required by manufacturer's instructions.

B. Exterior Storage:
   1. Store fabricated products above the ground, on blocking or skids, prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings, provide adequate ventilation to avoid condensation.
   2. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.

D. Protection After Installation:
   1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove when no longer needed.

E. Repair Damage:
   1. Repair damaged materials and equipment to new condition or replace with new, to the satisfaction of the Engineer. Refer to Conditions of the Contract.

1.06 NAMEPLATE DATA

A. Provide original component manufacturer's permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Locate nameplates in an accessible location.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 23

FIELD ENGINEERING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide and Pay for Field Engineering Services Required for Project:
   1. Survey work required in execution of Project.
   2. Engineering work for civil, structural or other professional engineering services specified or required to execute Contractor's construction methods.

1.02 QUALIFICATIONS OF SURVEYOR OR ENGINEER

A. Survey work during construction may be completed by the Contractor. However, all locations/elevations must be verified at the completion of the contract by a qualified land surveyor registered in the state in which the construction is being done. Final survey data shall be documented on the Record Drawings.

B. Engineering work by qualified professional engineer registered in the state in which the construction is being done.

1.03 SURVEY REFERENCE POINTS

A. Original basic horizontal and vertical control points for the Project are those designated on Drawings.

B. Locate existing control points, re-establish original control points, protect control points prior to starting site work, and preserve all permanent reference points during construction.
   1. Make no changes or relocations without prior written notice to Engineer.
   2. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
   3. Require surveyor to replace Project control points which may be lost or destroyed.
   4. Establish replacements based on original survey control.

C. Reconfirm all existing and original vertical elevation control points prior to the use of such points for project surveying. Reference control point for such reconfirmation is shown on Drawings.

D. Refer any apparent discrepancies to Engineer for resolution. Surveyor to assist Engineer with field work required for resolution of such apparent discrepancies.

1.04 PROJECT SURVEY REQUIREMENTS

A. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means:
   1. Site improvements:
   2. Stakes for grading, fill and topsoil placement.
   3. Utility slopes and invert elevations.
   4. Batter boards for structures.
   5. Building foundation, column locations, and floor levels.
   6. Controlling lines and levels required for mechanical and electrical trades.

B. From time to time, verify layouts by same methods as required for control of the Work and when requested by the Engineer.

C. The Contractor shall take reasonable efforts to protect all existing property corners, permanent bench marks, right-of-way markers, government established monuments, and similar reference points. If any must be disturbed, the monuments must be referenced before removal and replaced as soon as work in the area is completed. Referencing and replacing shall be done by a licensed surveyor, and in the case of U.S.G.S. monuments and NMDOT right-of-way markers, shall be a first order survey work.

1.05 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. On completion of improvements, prepare record drawings showing all dimensions, locations, and elevations of construction.

1.06 SUBMITTALS

A. Submit name and address of surveyor and professional engineer to Engineer.

B. Submit documents certifying current registration of surveyor and engineer.

C. On request of Engineer, submit documentation to verify accuracy of field engineering work.

D. Survey data and computations for all Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 23.17

NEW MEXICO DEPARTMENT OF TRANSPORTATION (NMDOT)
UTILITY PERMIT SURVEY REQUIREMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide and pay for Professional Survey Services required for the Project:
   1. Survey Work required in execution of the Project to complete "As-Built" Drawings in accordance with the New Mexico Department of Transportation Department (NMDOT) Utility Permit surveying requirements.
   2. All work within the right-of-way (ROW) under the jurisdiction of the NMDOT.

1.02 QUALIFICATIONS OF SURVEYOR

A. Qualified land surveyor registered in the State of New Mexico, acceptable to Contractor and Owner.

1.03 HIGHWAY UTILITY PERMIT FOR THIS PROJECT

A. Copy of executed Permit to install utility facilities within ROW is on file with the Engineer for viewing at the request of the Contractor.

B. Contractor shall comply with all Permit conditions identified in the Permit at no additional cost to the Owner.
   1. Contractor's attention is called to the following Special Requirements stated in the Permit:
      a. Contractor must provide As-Built Drawings within 30 days of completion of the installation pertaining to the location of the jack and bore casing installed. The location must be tied by a survey, performed and certified by a registered New Mexico Land Surveyor. Submit hard copies and electronic files of As-Built Drawings.
      b. Contractor required to notify Mr. Peter Kubiak, Engineering Coordinator, NMDOT, Phone: (505) 249-5718; e-mail: peter,kubiak@state.nm.us by completing the attached Traffic Control / Roadway Work Permit Form at least 5 days in advance of construction. Upon receipt of an approved Traffic Control Permit the Contractor will have permission to enter the NMDOT ROW.

1.04 UTILITY SURVEY REQUIREMENTS

A. All utility survey work shall be certified by a New Mexico Registered Land Surveyor.

B. Contractor shall provide "As-Built" horizontal and vertical utility location information in hard copy and electronic file in AutoCAD® .dwg (3D) format (AutoCAD® Release 14).

C. The standard horizontal datum shall be the North American Datum 1983 (NAD83) and the standard projections shall be the New Mexico State Plane Coordinate System 1983 (NMSPCS83).

D. The standard vertical datum shall be the North American Vertical Datum 1988 (NAVD88).

E. Submit data in CD ROM.

F. Utility location information shall be tied to NMDOT monuments and referenced to highway mile posts.

G. Provide description on the electronic file of survey control, horizontal datum, vertical datum used to prepare the "As-Built" documents, including the following:
1. NMDOT District Utility Permit Number (provided by Engineer).
2. Name, address, registration number, and telephone number of responsible land surveyor.
3. Date survey completed.
4. Equipment used to conduct the survey.
5. Horizontal and vertical control marks used to tie the survey to the NMSPC83 and NAVD88.
6. Ground to Grid combined scale factor used.
7. Utility Line Work: Elevations shall be provided every 500′ and at all survey break points, including all high and low points.
8. Structures: Elevations at all changes in elevations, i.e, top of structure surfaces, pipe inverts, bottom slab, etc.

1.05 RECORDS

A. On completion of improvements, prepare record (As-Built) Drawings showing all dimensions, locations, and elevations of construction as permitted under Part 1.04 of this Section.

1.06 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples.
1. Number of Sets: Four.
2. Printed Copy Drawing Size: 11″ x 17″.
3. Electronic File: AutoCAD® .dwg format as specified herein.
4. Submit before certifying Project is substantially complete. Project will not be considered substantially complete without complete submittal of utility permit survey data.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. Surveying services are incidental Work to the Contract Documents' Bid Items. No separate payment allowed.

END OF SECTION

SECTION 01 74 00

CLEANING AND WASTE MANAGEMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Execute cleaning, during progress of the Work, and at completion of the Work, as required by General Conditions.

1.02 RELATED REQUIREMENTS

A. Conditions of the Contract

B. Each Specification Section: Cleaning for specific products or work.

1.03 DISPOSAL REQUIREMENTS

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING SCHEDULE

A. Type 2 – For Grounds and Exposed Concrete Work:
   1. Broom clean exterior paved surfaces; rake clean other ground surfaces.
   2. Broom clean all concrete slabs.
   3. Remove grease, mastic, adhesives, dust, dirt, stains, labels and other foreign materials from all piping systems surfaces and equipment.
   4. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire Work is clean.

END OF SECTION

SECTION 01 74 17

STORM DRAINAGE DISCHARGE COMPLIANCE

PART 1 GENERAL

1.01 WORK INCLUDED

A. Prepare a Storm Water Pollution Prevention Plan (SWPPP) to control storm water discharges from construction activities during the Project that disturb one or more acres, and comply with all other requirements of the USEPA-NPDES Program.

B. Scope of Work:

1. Work includes compliance with the U.S. Environmental Protection Agency (EPA), National Pollution Discharge Elimination System (NPDES) Regulations for Storm Water Discharges from construction sites, per 40 CFR, Parts 122, 123, and 124. Additional information on the EPA Construction General Permit (CGP) and SWPPP for construction activities can be found at:
https://www.epa.gov/sites/production/files/2017-06/documents/2017_cgp_final_permit_508.pdf
https://www.epa.gov/npdes/2017-construction-general-permit-cgp
2. Develop and submit a site-specific SWPPP prior to commencement of construction, and implement and maintain Best Management Practices (BMPs) identified in this plan to control erosion, pollution, sediment, and runoff during the construction of the Project. Storm water pollution prevention practices shall meet the current standards of the industry and all of the requirements of the current CGP. Contractor is encouraged to use the SWPPP template and reporting forms provided at the referenced web site.
3. Contractor shall determine and identify in the SWPPP if the Project is in an Arid or Semi-Arid area as defined in Appendix A – Definitions and Acronyms, of the CGP.
4. If the disturbed area is less than five acres, the Project duration is short and avoids the wet season, and the erosivity index (R factor) for the site is low, Contractor may apply for a Low Erosivity Waiver (LEW) Certification. The LEW calculation procedures and Certification Form are found on the referenced EPA websites. Contractor may use the calculation tool on the following EPA website to determine whether or not the site is eligible for a LEW.
https://www.epa.gov/npdes/rainfall-erosivity-factor-calculator-small-construction-sites
If the site is eligible for a LEW and Contractor properly submits the LEW Certification Form, Contractor is exempt from the requirements to prepare a SWPPP. Although the Contractor is not required to prepare a formal SWPPP document, it shall still be responsible for general good housekeeping of the site such as track-out prevention, concrete washout, erosion control, litter control, and any other appropriate efforts.

5. Contractor shall conduct site inspections, monitoring, and testing as required in the CGP and complete reports within the time required.
6. Contractor shall maintain and update the SWPPP as necessary and required by the CGP.
7. Contractor shall have the SWPPP available for review at all times.
8. Contractor shall remove non-permanent BMPs at completion of the Project.
9. All work specified in this Specification Section shall be provided by Contractor under the bid item listed in the Bid Form or, if no bid item is listed, shall be provided as incidental work at no additional cost to Owner.

C. Compliance with Storm Drainage Discharge Requirements:
1. Contractor shall meet all requirements of the most current version of the NPDES General Permit for Discharge from Construction Activities (CGP).
2. Contractor shall file a Notice of Intent (NOI) at least 14 days prior to commencing earth-disturbing activities and is required to use EPA's electronic NOI system or "eNOIsystem" to prepare and submit the NOI. In addition to submitting the Contractor's NOI, the Contractor shall assist the Owner in a timely fashion with the preparation and submittal of the NOI that is required to be submitted by the Owner.
3. Contractor shall file a Notice of Termination (NOT) and is required to use EPA's electronic NOI system or "eNOIsystem" to prepare and submit the NOT. In addition to submitting the Contractor's NOT, the Contractor shall assist the Owner with the preparation and submittal of the NOT that is required to be submitted by the Owner.
4. Owner will assist Contractor with the necessary information for preparation and certification of its subsequent NOI and NOT.

D. Contractor shall also submit one (1) copy of the completed SWPPP to Owner at the time Contractor submits his NOI.

E. By completing the NOI, Contractor is certifying to Owner that a SWPPP has been completed in conformance with the CGP Permit and is in Contractor's possession.

F. Contractor is the designated "Operator" of the Permit and is solely responsible for execution of the Project construction in conformance with CGP Permit condition(s) and requirement(s), including work performed by any subcontractor(s). Contractor shall immediately correct conditions related to the Project that are in violation of Permit requirements. Failure by Contractor to correct such conditions in a timely manner may subject Contractor to fines and/or penalties.

G. Contractor shall indemnify, defend, and hold Owner and its Representative(s) harmless from any fines and/or penalties issued for violations of Permit conditions.

H. In the event Contractor fails to comply with NPDES Permit requirements, Owner retains the right to enter upon the Project site and perform corrective measures. Any costs associated with corrective measures shall be the responsibility of, and shall be paid by, Contractor. Owner shall be entitled to deduct such costs from remaining

Contract Amounts, and if insufficient Contract Amounts exist, Contractor shall reimburse Owner for any deficiency.

I. If payment for the SWPPP is listed as a bid item in the Bid Form, payment shall be made in increments equal to the percent complete on the overall Project.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 75 01

FIELD SERVICE REPRESENTATIVE

PART 1 GENERAL

1.01 FIELD SERVICE REPRESENTATIVE

A. Shall be employed by the manufacturer and shall regularly engage in field checkout, calibration, testing, trouble-shooting, installation supervision, and start-up of equipment or systems.

B. Shall have qualifications and experience acceptable to the Owner and the Engineer. Submit name and qualifications of Field Service Representative with the shop drawing submittal of the applicable equipment item.

C. A manufacturer's sales representative will not be acceptable as a field service representative unless the Contractor applies for and receives in writing a waiver for such from the Owner.

D. Shall be thoroughly familiar with the specific equipment or system for this project on arrival at the jobsite. The Field Service Representative shall perform installation supervision, field check-out, calibration, testing, troubleshooting, adjustment or other services as specified in the pertinent section.

E. The Engineer reserves the right to require a substitute Field Service Representative, at no extra cost to the Owner, if the Field Service Representative supplied by the manufacturer is not able to properly perform the required tasks.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEST EQUIPMENT

A. Coordinate requirements for test equipment with Field Service Representative and ensure that all necessary standard and special test, calibration, and diagnostic equipment is available for start-up testing.

END OF SECTION

SECTION 01 77 00

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Comply with requirements stated in Conditions of the Contract and in Specifications for administrative procedures in closing out the Work.

1.02 RELATED REQUIREMENTS

A. Conditions of the Contract. Fiscal provisions, legal submittals and additional administrative requirements.

B. Section 01 29 00 – Payment Procedures

C. Section 01 33 23 – Shop Drawings, Product Data, and Samples

1.03 SUBSTANTIAL COMPLETION

A. When Contractor considers the Work is substantially complete, Contractor shall submit to Engineer:
1. A written notice that the Work, or designated portion thereof, is substantially complete.
2. A list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, Engineer will make an inspection to determine the status of completion. If acceptable to Engineer and Owner, Engineer will notify Contractor in writing. Work is substantially complete when:
1. All systems are complete and functional.
2. All final Operation and Maintenance Manuals have been accepted.
3. Any required shakedown testing periods have been completed.
4. Utilities, alarms, electrical, area lighting, monitoring, controls, drains, piping, paving, and related components are in place and completed.
5. Facilities can be put to intended use.
6. Owner is able to use for intended use at no additional cost to Owner.

C. Should Engineer determine that the Work is not substantially complete:
1. Engineer will promptly notify the Contractor in writing, giving the reasons therefor.
2. Contractor shall remedy the deficiencies in the Work, and send a second written Notice of Substantial Completion to the Engineer.
3. Engineer will reinspect the Work.
4. Owner may charge Contractor for all of Engineer’s reinspection time and costs at Engineer’s standard billing rates through a credit by Change Order.

D. Contractor's warranty start date for equipment systems will be the date of Substantial Completion accepted by the Engineer / Owner for that specified equipment system.

E. After the Engineer and Owner have accepted the Work, or designated portion thereof, Owner will assume responsibility for operation and maintenance of the facilities and equipment, or designated portion thereof.

1.04 FINAL INSPECTION

A. When Contractor considers the Work is complete, Contractor shall submit written certification that:
   1. Contract Documents have been reviewed.
   2. Work has been inspected for compliance with Contract Documents.
   3. Work has been completed in accordance with Contract Documents.
   4. Equipment and systems have been tested in the presence of the Owner's representative and are operational.
   5. Work is completed and ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness after receipt of such certification.

C. Should Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to Engineer that the Work is complete.
   3. Engineer will reinspect the Work.

D. When the Engineer finds that the Work is acceptable under the Contract Documents, Engineer will request the Contractor to provide Closeout Submittals as listed in Paragraph 1.06.

1.05 REINSPECTION FEES

A. Should Engineer perform reinspections due to failure of the Work to comply with the claims of status of completion made by the Contractor:
   1. Owner will compensate Engineer for such additional services.
   2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

1.06 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. Evidence of compliance with requirements of governing authorities.

B. Warranties and Bonds: To requirements of General Conditions.

C. Evidence of Payment and Release of Liens: To requirements of General and Supplemental Conditions.

D. Consent of Surety: To requirements of General Conditions.

E. Project Record Documents: To requirements of Section 01 78 39.

F. Operating and Maintenance Data: To requirements of Section 01 78 23.

G. Spare Parts and Maintenance Materials: To requirements of Section 01 78 44.

1.07 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to Engineer.

B. Statement shall reflect all adjustments to the Contract Sum:
   1. The original Contract Sum.
   2. Additions and deductions resulting from:
      a. Previous Change Orders.
      b. Allowances.
      c. Unit Prices.
      d. Deductions from uncorrected Work.
      e. Deductions for liquidated damages.
      f. Deductions for reinspection payments.
      g. Other adjustments.
   3. Total Contract Sum, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

C. Engineer will prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.08 FINAL APPLICATION FOR PAYMENT

A. After receiving written notification from the Engineer that Contractor has completed all requirements specified in Paragraphs 1.03, 1.04, 1.06, and 1.07, Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the Contract Documents.

B. Contractor shall provide the consent of surety to final payment when submitting the Application for Final Payment.

C. Contractor shall provide all other documents specified in Supplementary Conditions SC-15.06.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Format and Content of Manuals

B. Submittal of Manuals

C. Schedule of Submittals

1.02 RELATED WORK

A. Section 01 29 00 – Payment Procedures

B. Section 01 77 00 – Contract Closeout

C. Section 01 79 01 – Manufacturer's Instruction of Owner's Personnel

D. Section 01 91 01 – Lift Station Shakedown Operations

1.03 QUALITY ASSURANCE

A. Preparation of data shall be done by personnel:
   1. Trained and experienced in maintenance and operation of the described products.
   2. Completely familiar with requirements of this Section.
   3. Skilled as a technical writer to the extent required to communicate essential data.
   4. Skilled as a draftsman competent to prepare required drawings.

B. Manuals for equipment and systems shall be prepared by the equipment manufacturer or system supplier.

1.04 FORMAT

A. Prepare data in the form of an instructional manual for use by Owner's personnel.
   1. Binders:
      a. Preliminary manuals: Heavy paper covers.
      b. Final manuals: Commercial quality substantial, permanent, 3-ring or 3-post binders with durable, cleanable plastic covers. Covers of adequate size to easily contain required information.

B. Cover and Spine: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:
   1. Title of Project.
   2. Identity of separate structure as applicable.
   3. Identity of general subject matter covered in manual.

C. Assemble and bind material in the same order as specified in Paragraph 1.06 with the material grouped in the same manner as the applicable portions of the CONTRACT DOCUMENTS.

D. Text: Manufacturer's printed data, or typewritten data on 20 lb. minimum, white, paper. Size: 8-1/2 x 11.

E. Drawings:
   1. Provide reinforced punched binder tab, bind in with text.
   2. Reduced to 8-1/2" x 11" or 11" x 17" and folded to 8-1/2" x 11".
   3. Where reduction is impractical, folded and placed in 8-1/2" x 11" envelopes bound in text.
   4. Suitably identified on drawings and envelopes.

F. Provide binder tab for each separate product, or each piece of operating equipment.
   1. Provide typed description of product, and major component parts of equipment.
   2. Provide indexed tabs corresponding to items listed in the table of contents.

1.05 CONTENT OF MANUALS

A. Table of Contents:
   1. Provide title of project.
   2. Contractor, name of responsible principal, address and telephone number.
   3. Schedule of products and systems, indexed to the content of the volume.
   4. List, with each product, the name, address and telephone number of:
      a. Subcontractor or installer.
      b. Maintenance contractor, as appropriate.
      c. Local source of supply for parts and replacement.
      d. Manufacturer.
   5. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

B. Product Data:
   1. Include only those sheets which are pertinent to the specific product.
   2. Annotate each sheet to:
      a. Clearly identify the specific product or part installed.
      b. Clearly identify the data applicable to the installation.
      c. Delete references to inapplicable information.
   3. Preventive maintenance information shall be given for each major component of every piece of equipment in the format attached to the end of this Section.

C. Drawings:
1. Supplement product data with drawings as necessary to clearly illustrate:
   a. Relations of component parts of equipment and systems.
   b. Control and flow diagrams.
2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
3. Do not use Project Record Documents as maintenance drawings.

D. Written Text:
1. Supplement product data for the particular installation.
2. Organize in a consistent format under separate headings for different procedures.
3. Provide a logical sequence of instructions for each procedure.

E. Warranties and Bonds:
1. Copy of each Warranty, Bond and Service Contract Issued.
2. Provide information sheet for Owner's personnel.
3. Proper procedures in the event of failure.
4. Instances which might affect the validity of warranties or bonds.

F. Provide an installation, operation and maintenance manual for each item of equipment or system listed in the schedule of manuals in the quantity listed in the submittal schedule.

G. Additional Requirements for Operation and Maintenance Data: The respective sections of specifications.

1.06 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Each Item of Equipment and Each System. Include and identify:
1. Description of unit or system and component parts.
2. Function, normal operating characteristics, and limiting conditions.
3. Performance curves, with engineering data and tests.
4. Complete nomenclature and commercial number of all replaceable parts.

B. Installation Instructions, include:
1. Manufacturer's complete installation instructions and recommendations.

C. Operating Procedures, include:
1. Startup, break-in, and routine normal operating instructions and sequences.
2. Regulation, control, stopping, shutdown and emergency instructions.
3. Summer and winter operating instructions, as applicable.
4. Special operating instructions.

D. Maintenance Requirements, include:
1. Routine procedures and guide for troubleshooting.
2. Disassembly, repair and reassembly instructions.
3. Alignment, adjusting, balancing and checking instructions.

4. Preventive maintenance information for each major component of every piece of equipment as required on the "Preventive Maintenance Information & Equipment Data Sheet" attached at the end of this section.

E. Servicing and Lubrication Schedule, provide:
1. List of lubricants required.
2. Lubrication information for each major component of every piece of equipment as required on the "Preventive Maintenance Information & Equipment Data Sheet" attached at the end of this section.

F. Provide manufacturer's printed operation and maintenance instructions.

G. Include sequence of operation by controls manufacturer.

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

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

J. Provide control diagrams by controls manufacturer as installed.

K. Provide other data as required under pertinent sections of specifications.

1.07 MANUAL FOR ELECTRIC AND ELECTRONIC ITEMS OR SYSTEMS

A. Description of system and component parts, include and identify:
1. Function, normal operating characteristics, and limiting conditions.
2. Performance curves, engineering data and tests.
3. Complete nomenclature and commercial number of replaceable parts.

B. Circuit Directories of Panelboards; provide:
1. Electrical service characteristics
2. Controls
3. Communications

C. Provide as-installed color-coded wiring diagrams.

D. Operating Procedures, include:
1. Routine and normal operating instructions.
2. Sequences required.
3. Special operating instructions.

E. Maintenance Requirements, include:
1. Routine procedures and guide to troubleshooting.
2. Adjustment, balancing and checking instructions.

F. Provide manufacturer's printed operation and maintenance instructions.

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

H. Provide other data as required under pertinent sections of specifications.

1.08 SUBMITTAL OF MANUALS

A. Preliminary Submittal of Manuals
   1. Quantity:
      a. Submit number of preliminary manuals required by Contractor plus number to be retained by Engineer.
      b. As scheduled.
   2. Submit prior to the date of shipment of equipment or system.
   3. Engineer will review for acceptance and return to Contractor with comments as appropriate.
   4. Resubmittal Process:
      a. If unacceptable, Contractor to resubmit same number of preliminary copies for Engineer's review.
      b. Manuals will not be reviewed in detail once determined by the Engineer that a manual is not acceptable.
      c. No partial payment will be made for equipment materials or related system materials delivered to the site until preliminary manuals for that equipment are submitted and are acceptable to the Engineer.

B. Final Submittal of Manuals
   1. Quantity:
      a. Submit number required by Contractor plus number to be retained by Engineer.
      b. As scheduled.
   2. Submit copies no less than 30 calendar days prior to putting equipment or system in service.
   3. Engineer will review and compare with accepted preliminary manual.
   4. If acceptable, manuals will be distributed as follows:
      a. Contractor: For project record documents.
      b. Engineer: For files.
      c. Owner: Held by Engineer for later transmittal to Owner.
   5. If not acceptable, all copies will be returned to Contractor for revision or retained by Engineer and the necessary revision data requested from Contractor, at Engineer's option.
   6. No portion of the Work is substantially complete until final equipment and system manuals relating to that portion of the Work are accepted by Engineer.
   7. Submit copies of any revisions found desirable during instruction of Owner's personnel, with instructions for insertion for revising copies of manual.

C. Funding agency funds may be withheld from Owner if Owner's acceptable operation and maintenance manual is not submitted as required by the agencies. If this occurs and such is partially attributable to a delay by the Contractor in submitting the required operation and maintenance materials:
   1. Owner may withhold payments from Contractor.
   2. Contractor shall not terminate or suspend work.
   3. No additional costs or Contract time shall be claimed by Contractor if Owner withholds payments.

D. If Contractor requires additional copies of the operation and maintenance manuals for the Contractor's, subcontractor's or suppliers' use, such may be submitted and will be returned upon review by the Engineer.

1.09 REIMBURSEMENT FOR ENGINEER'S REVIEW COSTS

A. For all manual reviews beyond one review of the preliminary manual and one review of final manual:
   1. Owner may charge Contractor for all of Engineer's review time and costs at Engineer's standard billing rates through a credit by Change Order.
   2. Engineer will perform these unscheduled reviews in the same manner as other unscheduled work.

1.10 SUBSTANTIAL COMPLETION

A. Project will not be considered substantially complete until final O&M Manuals and manufacturer's instruction of Owner's personnel have been accepted by Engineer.

1.11 SCHEDULE OF SUBMITTALS

A. Prepare O&M Manuals for pieces of equipment where specified in the individual specification sections.

B. Quantities to be Processed by Engineer:
   1. Preliminary Manuals: Submit Preliminary Manuals in **one** of the following formats:
      a. Electronic Format:
         1) Electronic file in searchable .pdf format, delivered via email or on one (1) CD.
         2) One (1) printed copy properly formatted in binder with labels and dividers as specified. Engineer will retain copy.
         3) Engineer's submittal review including submittal file will be returned to Contractor in electronic format.
      b. Or Printed Format:
         1) Two (2) printed copies properly formatted in binder with labels and dividers as specified.
         2) Engineer will return one (1) copy to Contractor.
         3) Any additional copies received will be discarded by Engineer.

2. Final Manuals: Submit Final Manuals in **each** of the following formats:
    a. Electronic Format:
        1) Three (3) copies of electronic files in searchable .pdf format, delivered on three (3) CDs.
    b. And Printed Format:
        1) Three (3) printed copies.
        2) Engineer will retain three (3) copies.

C. The "Preventive Maintenance Information & Equipment Data Sheet" at end of this Section shall be completed and submitted with the preliminary and final operation and maintenance manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PREVENTIVE MAINTENANCE INFORMATION
AND
EQUIPMENT DATA SHEET

1. Equipment Name: _____

2. Equipment Number: _____

3. Equipment Manufacturer: _____

   Address: _____

   Phone: ( ) _____

4. Equipment Supplier: _____

   Address: _____

   Phone: ( ) _____

5. Nameplate Data:
   Drive Unit: _____ hp, _____ rpm, _____ volts, _____ O _____ FLA
   Motor class (dripproof, TEFC, etc.) _____
   Manufacturer _____
   Model No. _____ Serial No. _____
   Other _____

   Driven Unit: Flow with units _____
   Discharge Pressure with units _____
   Equipment Type _____
   Model No. _____ Serial No. _____
   Other _____

6. Method of Power Transmission (direct coupled, V-belt, etc.) _____
   _____

7. Maintenance Requirements (list on next sheet)

   Maintenance Operation: List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable.

   Frequency: List required frequency of each maintenance operation.

   Lubricant (if applicable): Refer by symbol to recommended lubricant from list in Item

8. Comments: Give other applicable comments concerning maintenance operation.

Maintenance Operation (including any special tools required) | Frequency | Lubricant | Comments

A.

B.

C.

Use additional sheets if necessary.

9. Lubricant List (provide Mobil number in addition to any other recommended manufacturers):

Reference Symbol	Mobil	Chevron	Shell	Arco	Or Equal
List symbols used in Item 7, above	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

10. This data sheet prepared by: _____

Firm: _____

Date: _____

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Maintain one printed record copy of the following record documents at the site for the Owner:
   1. Drawings.
   2. Engineer's response to Requests for Information (RFIs).
   3. Engineer Field Orders or written instructions.
   4. Accepted Shop Drawings, Product Data and Samples.
   5. Field Test Records.
   6. Receipts for delivery of items to Owner.

B. Prepare and submit to Owner record utility location survey data as specified herein.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store documents and samples in Contractor's field office apart from documents used for construction.
   1. Provide files and racks for storage of documents.
   2. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with specification format.

C. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by Engineer and Owner.

1.03 MARKING DEVICES

A. Provide felt tip marking pens for recording information in the color code designated by Engineer.

1.04 RECORDING

A. Label each document "PROJECT RECORD" in neat, large, printed letters.

B. Record information concurrently with construction progress.
   1. Do not conceal any work until required information is recorded.

C. Drawings: Legibly mark to record actual construction:
   1. Changes made by Addenda.
   2. Depths of various elements of foundation in relation to finish first floor datum.
   3. Horizontal and vertical locations of underground utilities and appurtenances, including bends in pipes; and internal utilities and appurtenances concealed in the construction. Measure and show locations on the Record Drawings by either:
      a. Referenced to permanent surface features or referenced to visible and accessible features of the structure.
      b. Or tabulate and plot coordinates on the Record Drawings measured using survey grade GPS or GNSS to an accuracy of 0.1 meter (4 inches) using a baseline tied into the project coordinate system control points.
   4. Field changes of dimension and detail.
   5. Changes made by Field Order or by Change Order.
   6. Details not on original Contract Drawings.
   7. For sewer lines: Invert elevations at manholes, line and manhole alignment and locations, and location of each service line referenced by distance from downstream manhole and distance from sewer centerline to end of service line.

1.05 SUBMITTALS

A. At Contract close-out, deliver Record Documents to Engineer for the Owner.

B. Submit to-scale dimensioned electronic drawing files of major equipment items installed that were not the design basis manufacturer. Drawings shall show general arrangement plan and sections. Drawing files shall be in AutoCAD DWG format.

C. Submit hard copies and electronic files of record utility location survey data as specified in Part 3.

D. Accompany Submittals with transmittal letter in duplicate, containing:
   1. Date.
   2. Project title and number.
   3. Contractor’s name and address.
   4. Title and number of each Record Document.
   5. Signature of Contractor or his authorized representative.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 RECORD UTILITY LOCATION SURVEY REQUIREMENTS

A. Provide and pay for professional survey services required for the Project.
   1. Survey work shall be performed by a land surveyor registered in the State of New Mexico, acceptable to Engineer and Owner. Submit name of surveyor prior to proceeding with survey.

B. Contractor shall provide “as-built” horizontal and vertical utility location information in two hard copies and an electronic file in AutoCAD DWG (3D) format (AutoCAD Release 14), and ArcGIS 10.3 Geodatabase file.

C. The standard horizontal datum shall be the North American Datum 1983 (NAD83) and the survey shall be the New Mexico State Plane Coordinate System 1983 (NMSPCS83).

D. The standard vertical datum shall be the North American Vertical Datum 1988 (NAVD88).

E. Submit in electronic format.

F. Provide description on the electronic file of survey control, horizontal datum, vertical datum used to prepare the “as-built” documents, including the following:

1. Name, address, registration number, and telephone number of responsible professional land surveyor.
2. Date survey is completed.
3. Equipment used to conduct the survey.
4. Horizontal and vertical control marks used to tie the survey to the NMSPCS83 and NAVD88.
5. Ground to Grid combined scale factor to be used.
6. Map Projection: World Geodetic System WGS84 Web Mercator Auxiliary Sphere.
7. Utility Line Work: Elevations shall be provided every 500 feet and at all grade break points, including all high and low points.
8. Pipes and Appurtenances: All changes in elevations, i.e., top of pipe surfaces, pipe inverts, ground elevations (including hydrants and valves), etc. shall be measured and recorded.
9. Layer and GIS Attributes to include:
    a. Water Service Meters: Type, manufacturer, model number, serial number, register multiplier.
    b. Air Valves: Type (air release, air / vacuum, combination, well service), manufacturer, model number, installation date.
    c. Pressure Regulating Valves: Type (reducing, relief, sustaining, altitude), inlet size, port size, manufacturer, model number, pressure settings, installation date.
    d. Buried Isolation Valves: Type (gate, butterfly, plug), size, manufacturer.
    e. Fire Hydrants: Type (dry barrel, wet barrel), size, manufacturer, model number.
    f. Water and Sewer Pipes: Size, material, depth to top of water pipes, invert elevations of sewer pipes, date installed.
    g. Wastewater Lift Stations and Water Pump Stations:
        1) Pumps: Type, fluid pumped, manufacturer, model and impeller numbers, serial number, date installed.
        2) Pump Motors: Horsepower, voltage, phase, drive (constant speed or variable).

h. Manholes: Depth, inlet and outlet pipe sizes.
i. Chlorination Systems: Form of chlorine used (liquid bleach, tablets, gas, on-site generation), ventilation fans information, dose pump information (type, dose setting, manufacturer, model number, serial number), installation date.
j. Tanks: Type (ground, buried, elevated), volume, diameter, height, overflow elevation, material (welded steel, bolted steel, concrete), installation date.

G. Survey Submittals:
1. Submit before certifying Project is substantially complete. Project will not be considered substantially complete without complete Submittal of utility survey data and GIS attributes.

PART 4 PAYMENT

4.01 RECORD DRAWINGS

A. Project record documents are incidental Work to the Contract Documents' Bid Items for which no separate payment will be made.

B. No payment will be made to the Contractor for any portion of the Work for which the project record documents are not complete.

4.02 UTILITY SURVEY

A. All surveying and GIS services are included in the Bid Schedule for this Work.

END OF SECTION

SECTION 01 78 40

DELIVERIES TO OWNER

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDE

A. Obtain signature of Owner's representative's on Master List developed per Section 01 78 44 – Spare Parts and Maintenance Materials, for all spare parts, supplies, maintenance materials, salvage, and similar items delivered to Owner.

B. Keep Master List and delivery receipts with Project Record Documents.

C. All deliveries to Owner shall be coordinated to occur during hours designated by Owner's warehouse for receiving such items as described in Paragraph A.

D. Deliver all materials to Owner at one time at end of the Project. Payment for Extra Materials will not be made until after the Owner has accepted delivery.

E. Provide copy of Master List to both Owner and Engineer once all deliveries have been completed.

F. The Owner and/or Engineer will check the delivered items against the Master List. If the delivery is not complete and as stated on List, or if items are not correctly marked, then provide a schedule of when the remaining items shall be delivered.

1.02 RELATED REQUIREMENTS

A. Section 01 78 39 – Project Record Documents

B. Section 01 78 44 – Spare Parts and Maintenance Materials

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 44

SPARE PARTS AND MAINTENANCE MATERIALS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDE

A. Provide spare parts and maintenance materials as specified in this Section and in specifications for work in Divisions 2 through 48 that are part of this project.

1.02 RELATED REQUIREMENTS

A. Section 01 78 40 – Deliveries to Owner.

1.03 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
   1. Prepare and submit a Master List of all spare parts and maintenance materials to be delivered to Owner. Specific requirements for those spare parts and maintenance materials to be delivered are as stated within individual Specification Sections for work in Divisions 2 through 48.

1.04 MAINTENANCE MATERIALS

A. Provide:
   1. Lubricant for all equipment and facilities sufficient for three months normal usage, unless specified otherwise.
   2. Any non-standard tools required to adjust or service equipment supplied.

B. Label all materials by equipment name and usage.

1.05 SPARE PARTS

A. Label and identify by equipment name, part name, part number.

B. Packaged for storage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 79 01

MANUFACTURER'S INSTRUCTION OF OWNER'S PERSONNEL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Instruction of Owner's Personnel

B. Video Recording of Manufacturer's Instruction

C. Schedule of Instruction

1.02 QUALITY ASSURANCE

A. Instruction shall be performed by a qualified, experienced regular employee of the equipment or system manufacturer or a full-time field service representative (not sales personnel) approved by the equipment or system manufacturer.

1.03 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated personnel in the operation, adjustment and maintenance of all scheduled products, equipment and systems.

B. Manufacturer's Operation and Maintenance Manual shall constitute the basis of instruction for:
   1. Review of contents of manual with Owner's personnel in full detail to explain all aspects of operation and maintenance.
   2. Review in field with Owner's personnel in full detail the operation and maintenance of each scheduled system or equipment.

C. Additional requirements for specialized instruction of Owner's personnel are given in the detailed equipment specifications.

D. Submit in writing proposed dates for instruction of Owner's personnel at least 15 days in advance of date when instruction is proposed to start; resubmit alternate schedule if proposed dates are not acceptable to Engineer or Owner.

E. Do not begin instruction of Owner's personnel until equipment for which instruction is required is fully operational and functioning satisfactorily and Final Operation and Maintenance Manuals for same have been reviewed and accepted by Engineer.

F. If the Engineer or Owner judges the instruction to be incomplete, inadequate, or inaccurate, additional instruction shall be scheduled and provided at no additional cost to the Owner.

G. Prepare and include additional data when the need for such data becomes apparent during the instruction of Owner's personnel or as necessary to provide complete operation and maintenance instructions.

1.04 VIDEO RECORDING OF MANUFACTURER'S INSTRUCTIONS

A. If scheduled, video record the equipment manufacturer's instructions to the Owner's personnel. Furnish digital video files on DVD or other media compatible with standard playback equipment and as agreed upon beforehand with Owner. Edit files to include only material relevant to instruction.

B. For instruction which will be video recorded, coordinate with persons providing the instruction to provide the following:
   1. Provide to Engineer when instruction is scheduled, detailed outline of topics, materials, procedures, information, etc. to be covered during instruction.
   2. Provide instruction and presentation in format that can be easily video recorded.
   3. Cooperate with video recording efforts if instruction is recorded by others.

1.05 SCHEDULE OF INSTRUCTION

A. Instruct Owner's personnel on pieces of equipment where specified in the individual specification sections or as scheduled herein.

B. Contractor shall video record the equipment manufacturer's instruction to the Owner's personnel and provide two copies of each video file. Label the front side of each video disk with the contents of the file.

C. See "Training Schedule" attached to end of this Section. Verify that all training requirements specified in the Contract documents are listed on the Training Schedule. Provide all training specified in the Contract Documents whether or not the sessions are listed on the Schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

TRAINING SCHEDULE

SECTION NO.	EQUIPMENT	NO. OF SESSIONS	MINIMUM HOURS PER SESSION	OWNER'S PERSONNEL TO ATTEND		COMMENTS
				Maint.	Oper.	
41 22 00	Hoists and Cranes	1	2	✓	✓	
43 25 13	Submersible Sewage Pumps	1	4	✓	✓	

END OF SECTION

SECTION 01 91 01

LIFT STATION SHAKEDOWN OPERATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide personnel, equipment, supplies and services for verification and shakedown of systems.

1.02 RELATED REQUIREMENTS

A. Section 01 77 00 – Contract Closeout

B. Section 01 78 23 – Operation and Maintenance Data

C. Section 01 79 01 – Manufacturer's Instruction of Owner's Personnel

1.03 SHAKEDOWN

A. Not less than number of calendar days scheduled:
   1. All major process, maintenance, operations, and monitoring equipment fully functional before and throughout entire scheduled period.
   2. If equipment fails during shakedown, required shakedown scheduled period restarted.
   3. Once shakedown operations started, Contractor to continue shakedown operations until scheduled shakedown period is achieved.

B. Prior to the commencement of the shakedown operations, the following work must be completed and approved by the Engineer:
   1. All equipment must be certified in writing by the manufacturer's representative that the equipment is installed properly, is functioning properly, and is ready for use.
   2. Complete all electrical, instrumentation, and controls testing requirements per Section 40 60 20 – Installation and Testing of Control Circuits and Devices, and Section 40 80 00 – Plant Process Control Commissioning.
   3. Contractor to flush out all new piping and complete all pressure testing on exposed and buried piping, as applicable.
   4. Contractor responsible for all damage to any pump from debris left in new piping systems, and for consequential damages, such as, but not limited to, spills.
   5. Wastewater treatment plant (constructed by others at a site located south of this Project) must also be ready for Shakedown Operations.

C. Contractor:

1. Supervise operation, operate, maintain, monitor, adjust all equipment and facilities.
2. Notify Engineer and Owner in writing 10 calendar days prior to shakedown.
3. Include shakedown operation in Contract time.
4. With notice of shakedown, include proposed written Schedule of all field instruction which has yet to be provided in accordance with Section 01 79 01 – Manufacturer's Instruction of Owner's Personnel, for review by Engineer and Owner; all instruction should be scheduled to facilitate Owner's and Engineer's participation. Revision of proposed schedule may be required to accomplish this objective.
5. Where practical for the equipment or system involved, instruction as required by Section 01 79 01 – Manufacturer's Instruction of Owner's Personnel, to occur prior to shakedown; all other instruction to occur within first 50 percent of shakedown operations unless specifically approved in writing by Engineer.
6. Request and coordinate use of potable water with Owner's representative.
7. Provide all labor, equipment, temporary piping, pumping and appurtenances for filling wet wells and basins with water for clean water test.
8. Have scheduled component or system manufacturer's field service representatives on-site during system shakedown. Coordinate with Engineer to schedule manufacturer's service representatives to be on-site during system shakedown.
9. Operate system making all adjustments to equipment, valves and system requested by Owner's staff.
10. Provide qualified Contractor employee(s) available to make operational adjustments any time required by Owner's staff.
11. Provide equipment manufacturer's recommended maintenance.
12. Provide facilities housekeeping and cleaning.
13. Deliver required spare parts, lubricants, maintenance tools, and equipment to Owner.
14. Have trades and specialists on-site during system shakedown to adjust, trouble shoot, and correct components, systems, and associated facilities as required.
15. Verify all system components and systems are fully functioning, calibrated, and ready to be put into service under all operating, emergency and alarms conditions.
16. Contractor responsible for all damages resulting from backups, spills and any other discharge violations during the construction period and shakedown period which are within its control.
17. Demonstrate to Engineer and Owner that system components and systems are fully functional, calibrated, and system is ready to be put into service.
18. Complete any required training of Owner's staff by equipment manufacturers.
19. Continue until scheduled system shakedown time has successfully occurred and substantial completion of system is certified by Engineer.

20. If Contractor requests Engineer to observe shakedown operations and Engineer must make additional visits because Work is not ready, Owner may charge Contractor for all of Engineer's additional visit time and costs at Engineer's standard billing rated through a credit by Change Order.

1.04 SYSTEM SHAKEDOWN INTERRUPTION

A. Definitions:
1. "Level 1 interruption" means:
   a. Failure of any single system component when system can, and does, continue to operate and be controlled and monitored as intended and failure is remedied within 24 hours.
   b. Subsequent failure(s) of the same component cannot be classified as a Level 1 interruption.
2. "Level 2 interruption" means:
   a. Failure of any single system component which interrupts system functionability, reliability, control, monitoring or operation for less than 8 hours, or
   b. Concurrent period of time when two system components have failed when system can, and does, continue to operate and be controlled and monitored as intended and failures are remedied within 24 hours of first component failure, or
   c. Single system component failure which meets the requirements for a Level 1 interruption except for being a subsequent failure(s) of the same component, or
   d. When more than two Level 1 interruptions have occurred during the shakedown of a system, or
   e. Single system failure which would meet the requirements for a Level 1 interruption except failure not remedied within 24 hours.
   f. Subsequent failures(s) of any component causing a Level 2 interruption cannot be classified as a Level 2 interruption.
3. "Level 3 interruption" means:
   a. Any component or system failure which interrupts system functionality, reliability, control, monitoring or operation for more than 8 hours, or
   b. When more than two Level 2 interruptions have occurred during the shakedown of a system, or
   c. Component failure(s) which would meet the requirements for a Level 2 interruption except for being a subsequent failure of the same component, or
   d. Single system component failure which would meet the requirements for a Level 2 interruption except failure not remedied within 8 hours, or
   e. Any other failures which are not a Level 1 or Level 2 interruption.
4. Failure includes components not being calibrated.

B. If Level 1 interruption occurs:
1. Continue system shakedown operations.
2. Shakedown time continues to run.

C. If Level 2 interruption occurs:
   1. Continue system shakedown operations.
   2. Shakedown time suspended until all components and systems are fully functional.
   3. Verify that components that have failed are fully functional and ready to be put back into service, including related monitoring and control facilities.
   4. Reimburse Owner for billings by Engineer for Engineer's costs in attending component verification activities.

D. If Level 3 interruption occurs:
   1. Continue shakedown operations.
   2. Verify that all system components are fully functional, calibrated, and ready to be put back into service under all operating, emergency and alarm conditions.
   3. Restart shakedown starting at 0 (zero) time.
   4. Reimburse Owner for billings by Engineer for Engineer's costs in attending component and/or system verification activities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SHAKEDOWN OPERATIONS

A. Operate the systems defined in Section 01 12 16 – Work Sequence, and continue shakedown operations throughout the scheduled period.

3.02 SCHEDULE

A. Clean Water Functional Testing:
   1. Submersible Pump Installation and Operation:
      a. Temporarily connect to forcemain piping at magnetic flow meter vault and direct temporary pipe to a temporary 10,000 gallon storage tank (minimum) provided by Contractor, located near wet well with 12" drain pipe and valve to drain temporary tank into wet well.
      b. Fill wet well with clean water and operate each pump long enough to confirm pump can meet the design point as specified.
   2. Motorized Jib Crane Operation: Confirm electric controls operate as designed.
   3. Washwater System: Confirm all hydrants are operable.

B. Clean Water Shakedown Test:
   1. Fill temporary storage tank with clean water.
   2. Test all mechanical equipment, instrumentation and controls within each of the following systems:
      a. New Abajo Lift Station – Pump Test to Demonstrate Pump Operations:
         1) Pump 1 (lead pump) Standard Operation: With wet well filling, pump turns "on" automatically; with water level dropping in wet well, pump turns "off" automatically. Demonstrate this process three times.

2) Pump 2 Standard Operation: Switch lead pump to Pump 2. With wet well filling, pump turns “on” automatically; with water level dropping in wet well, pump turns “off” automatically. Demonstrate this process three times.
3) Pump 3 Standard Operation: Switch lead pump to Pump 3. With wet well filling, pump turns “on” automatically; with water level dropping in wet well, pump turns “off” automatically. Demonstrate this process three times.
4) Disable the lead pump and verify that lag pump will turn on automatically. Demonstrate this process three times.
5) Switch the lead to the second pump. Disable the lead pump and verify that lag pump will turn on automatically. Demonstrate this process three times.
6) Switch the lead to the third pump. Disable the lead pump and verify that lag pump will turn on automatically. Demonstrate this process three times.
7) Disable all three pumps and verify that the high water level alarm functions.
8) Enable lead and lag pumps while wet well is at high water level and start them sequentially at minimum speed. Slowly ramp up speed to full speed with both pumps operating to demonstrate peak flows through the New Abajo Lift Station. Demonstrate this process for 3 consecutive hours.
9) Pump test to be demonstrated by pump manufacturer’s Field Service Representative and Contractor’s Electrical Subcontractor.
10) Repeat pump testing until all pumps are tested successfully in accordance with the above requirements.

3.03 SUBSTANTIAL COMPLETION

A. Refer to Section 01 77 00 – Contract Closeout, for description of Substantial Completion.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 WORK INCLUDED

A. Cast-In-Place Concrete

B. Reinforcing Steel

C. Forms

D. Admixtures

E. Embedments

1.02 ADDITIONAL REQUIREMENTS SPECIFIED ELSEWHERE

A. Section 01 45 23 – Testing Laboratory Services.

1.03 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Concrete mix design, including aggregate source, gradation, and specific gravity, and cement chemical composition.
   2. Proposed admixtures, per ACI 318.
   3. Reinforcing bar lists, fabrication, and placement Drawings for structures, in conformance with ACI 315R – Guide to Presenting Reinforcing Steel Design Details.
   4. Concrete accessories.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Storage:
   1. Cement and fly ash:
      a. Store in moisture-proof enclosures.
      b. Do not use if caked or lumpy.
   2. Aggregate: Store to prevent segregation and inclusion of foreign materials.
   3. Reinforcing steel: Store on supports which will keep it from contact with the ground.
   4. Rubber and plastic materials:
      a. Store in a cool place.
      b. Do not expose to direct sunlight.

PART 2 PRODUCTS

2.01 MATERIALS

A. Forms:
1. Chamfer Strips: Clear white pine, surface against concrete planed.
2. Form Coating: Industrial lubricants Master Builders Solutions US, LLC "MasterFinish Series", "Nox-crete Form Coating", "L&M Debond", Protex "Pro-Cote", Richmond "Rich Cote", or Engineer reviewed equivalent.
3. Form Release Agent: Release agent that will not adversely affect concrete or interfere with the application of coatings. Master Builders Solutions US, LLC "MasterFinish RL Series"; or Engineer reviewed equivalent.
4. Form Ties: Removable end, permanently embedded body type not requiring auxiliary spreaders, with cones on outer ends, embedded portion 1" minimum back from concrete face. If not provided with threaded ends, constructed for breaking off ends without damage to concrete.
5. Earth cuts shall not be used as forms for vertical surfaces, unless indicated on Project Drawings.

B. Reinforcing Steel:
1. Bars: ASTM A615, Grade 60.
2. Welded Wire Reinforcement: ASTM A1064 - Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3. Bar supports: PS7; CRSI Class B, fabricated from galvanized wire.

C. Welded Wire Reinforcement: ASTM A1064, furnished in flat sheets.

D. Fibrous Reinforcement:
1. Plastic Shrinkage Cracking Control During Curing: Synthetic microfibers, monofilament or fibrillated polypropylene microfibers, engineered and designed for use in concrete, confirming to ASTM C1116 Type III products. Master Builders Solutions US, LLC "MasterFiber M or F Series", or Engineer reviewed equivalent.
2. Temperature and Shrinkage Reinforcement: Synthetic macrofibers engineered and designed for use in concrete, conforming to ASTM C1116 Type III products. Master Builders Solutions US, LLC "MasterFiber MAC Series", or Engineer reviewed equivalent.

E. Concrete:
1. Cement: ASTM C150, Type I-II with average tricalcium aluminate (C_3A) content no greater than 5%. Use Type III only with prior written approval of Engineer.
2. Fly ash: ASTM C618, Class F, except loss on ignition not more than 5%
3. Fine aggregate: Clean, natural sand, ASTM C33.
4. Coarse aggregate: Crushed rock, natural gravel or other inert granular material, ASTM C33 except clay and shale particles no more than 1%.
5. Water: ASTM C1602 Clean, fresh and potable.

6. Admixtures:
    a. Air-Entraining Admixture: ASTM C260; Master Builders Solutions US, LLC “MasterAir Series”, Grace “Darex AEA”, Sika “AEK”, or Engineer reviewed equivalent.
    b. Water-Reducing Admixture: ASTM C494, Type A; Master Builders Solutions US, LLC “MasterPozzolith Series or MasterPolyheed Series”; Sika “Plastocrete 161”, or Engineer reviewed equivalent.
    c. Retarding Admixture: ASTM C494, Type B; Master Builders Solutions US, LLC “MasterSet R Series or MasterSet DELVO Series”, Grace “Duratard HC”, Protex “Protard”, Sika “Plastiment”, or Engineer reviewed equivalent.
    d. Accelerating Admixture: ASTM C494, Type C494, Type C; Master Builders Solutions US, LLC “MasterSet AC 534 or MasterSet FP 20”; Sika “SikaSet NC”, or Engineer reviewed equivalent.
    e. Water-Reducing Retarding Admixture: ASTM C494. Type D; Master Builders Solutions US, LLC “MasterSet R Series or MasterSet DELVO Series”, or Engineer reviewed equivalent.
    f. Water-Reducing Accelerating Admixture: ASTM C494, Type E; Master Builders Solutions US, LLC “MasterSet FP 20", or Engineer reviewed equivalent.
    g. High-Range Water-Reducing Admixture: ASTM C494, Type F; Master Builders Solutions US, LLC “MasterGlenium Series or Master Rheobuild 1000”, Grace “WRD A-HC”, Sika “Plastocrete”, or Engineer reviewed equivalent.
    h. Workability-Retaining Admixture: ASTM C494, Type S; Admixture shall retain concrete workability without affecting time of setting or early-age strength development. Master Builders Solutions US, LLC “MasterSure Z 60”, or Engineer reviewed equivalent.
    i. Strength-Enhancing Admixture: ASTM C494, Type S; Liquid crystalline calcium silicate hydrate nanoparticle admixture that increases both early- and late-age strength development without affecting concrete setting time. Master Builders Solutions US, LLC “Master X-Seed 55”, or Engineer reviewed equivalent.
    j. Permeability-Reducing Admixture: ASTM C494, Type S; Shall be a Portland cement-based crystalline capillary waterproofing admixture that reacts in concrete to form non-soluble crystalline hydration products in the capillary pores of the concrete. Master Builders Solutions US, LLC “MasterLife 300 Series”, or Engineer reviewed equivalent.
    k. Corrosion-Inhibiting Admixture: Shall be a nominal 30% solution of calcium nitrate or an amine/ester-based organic corrosion-inhibiting admixture. Master Builders Solutions US, LLC “MasterLife CI 30 or MasterLife CI 222”, or Engineer reviewed equivalent.
    l. Shrinkage-Reducing Admixture: ASTM C494, Type S; Master Builders Solutions US, LLC “MasterLife SRA Series or MasterLife CRA 007”, or Engineer reviewed equivalent.

m. Alkali-Silica Reaction Inhibiting Admixture: ASTM C494, Type S; Master Builders Solutions US, LLC "MasterLife ASR 30", or Engineer reviewed equivalent.

n. Color Pigment: Colored water-reducing admixtures, color stable, free of carbon black, nonfading, and resistant to lime and other alkalis. Master Builders Solutions US, LLC, or Engineer reviewed equivalent.

F. Accessories:

1. Polyethylene film: PS17, 6 mil.
2. Membrane curing compound and floor sealer: FS TT-C-600, Type 1; chlorinated rubber, minimum 18% solids or acrylic-based; Master Builders Solutions US, LLC "MasterKure CC Series"; Grace "Dekote", Process Solvent "Concrete Treatment ALX-9", Protex "Triple Seal Series CRD-18", TK Product "Tri-Kote TK-18", or Engineer reviewed equivalent.
3. Expansion and contraction joint: Elastic
   a. Rubber: Dumbell, 9" wide, 3/8" thick with 3/4" bead on each end; WR Grace, U.S. Rubber, William or Engineer reviewed equivalent.
   b. PVC: Ribbed or serrated, 9" wide, 3/8" thick with "U" or "O" bulb closed center section; Sika Greenstreak, WR Grace, WR Meadows, Vinylex or Engineer reviewed equivalent.
4. Exterior expansion joint material: Bituminous impregnated felt fiberboards; ASTM D994; or asphalt impregnated cellular fibers, ASTM D1751.
5. Bond break joint material: 30 lb. asphalt saturated felt, ASTM D226.
6. Interior slab construction joint material: Preformed 20 gage steel or as indicated on Drawings.

2.02 CONCRETE MIX

A. Comply with ASTM C94.

B. Water to Cementitious Material Ratio: Maximum 0.50 .

C. Fly Ash: Not less than 10% and not more than 25% of the total cementitious material weight.

D. Slump: Maximum 4.0", unless otherwise scheduled. Maximum of 9.0" for concretes containing a high-range water reducing admixture, unless otherwise scheduled.

E. Compressive Strength: 28 days - 4000 psi, unless otherwise scheduled or shown on the Drawings.

F. Volumetric Air Content: 4.5% ± 1.5%, air content shall not exceed 3% for interior slabs to be hard-trowel finished.

G. Admixtures:

1. Content, batching method, and time of introduction in accordance with the manufacturer's recommendations for compliance with this Specification.
2. Include admixtures required to meet job conditions.

3. Calcium chloride shall not be used.

H. Coarse Aggregate:
1. Maximum nominal dimension in accordance with ACI 318.

I. Add fibrous reinforcing (type and dosage as recommended by manufacturer) to concrete at batch plant for all concrete where indicated on Drawings.

J. Consistency:
1. Suitable for the placement conditions.
2. Slump uniform.
3. Aggregate floating uniformly throughout the concrete mass.
4. Flow sluggishly when vibrated or spaded.
5. Adjust mix in field, with Engineer's approval, as required to meet Specifications.

2.03 FABRICATION

A. Reinforcing Steel:
1. Fabricate in accordance with ACI 315 and 318 except as specified or indicated on Drawings.
2. Accurately fabricated.
3. Free from loose rust, scale, and contaminants which will reduce bond.

PART 3 EXECUTION

3.01 INSTALLATION

A. Forms:
1. In accordance with ACI 347.
2. Mortartight.
3. Exposed concrete surfaces free from irregularities.
4. True to line, grades, and dimensions shown on the Drawings.
5. Rigid and properly braced.
6. Ties arranged so that metal will not show or discolor concrete surface.
7. Bevel or chamfer exterior corners.
8. Coat forms with acceptable release material.

B. Reinforcing Steel:
1. Remove loose rust, scale, grease or any coating which may impair bond to concrete. Remove all rust that can be wiped off with a cloth.
2. Provide supports to provide minimum cover and spacing.
3. Provide splice lengths as required by ACI 318.

C. Embedments:
1. Accurately placed for the purpose intended.
2. Remove loose rust, scale, and other foreign matter before placing concrete. Remove all rust that can be wiped off with a cloth.

D. Concrete:
1. Place before initial set has occurred, but in no event after the concrete has contained its water content for more than 30 minutes, unless admixtures are used properly to extend the time and the admixture manufacturer can demonstrate successful performance under similar job conditions.
2. Place concrete on compacted moist surfaces, free from standing or running water.
3. Concrete to be conveyed and placed in an approved manner to prevent segregation of the coarse aggregate.
4. Cold Weather Concreting:
   a. Comply with ACI 306.1.
5. Hot Weather Concreting:
   a. Comply with ACI 305.1.

E. Expansion and Contraction Joints:
1. Provide as indicated on the Drawings.

F. Finishing:
1. Not required on buried surfaces.
2. No special concrete or cement mortar topping allowed for slab finish.
3. Slabs brought to true and even finish by screeding, floating, and finishing to product a smooth impervious surface, free from blemishes.
4. Unless otherwise specified or shown on the Drawings, a steel trowel finish shall be applied.
5. Excess water shall not be present when the finish is made.

G. Curing:
1. Cure concrete by approved method which will keep surfaces adequately wet or protected from moisture loss for the curing period.

H. Repairing Defective Concrete:
1. Repair defects in formed concrete surfaces within 24 hours.
2. Replace defective concrete within 48 hours.
3. Cut out and remove to sound concrete honeycombed or otherwise defective concrete.
4. Cut edges square to avoid feathering.
5. Comply with ACI 301 section on repairing defective concrete.
6. Perform repair work so as not to interfere with thorough curing of adjacent concrete.
7. Adequately cure repair work.

3.02 FIELD QUALITY CONTROL

A. Perform Field Control Test:
1. Tests by personnel certified to ACI Field Testing Technician Grade 1.
2. Make tests in presence of Engineer’s representative.
3. Provide all equipment, supplies, and the services of one or more employees, as required.
4. The test frequencies specified are minimum; perform additional tests as required by the job conditions.

B. Testing Frequency: Obtain at least one composite sample for each 150 cu. yd., or fraction thereof of each concrete mixture placed each day.

C. Slump: Perform a test for each load in accordance with ASTM C143.

D. Air Content: Test one sample from one of each three batches made and from each batch from which test cylinders are made, in accordance with ASTM C231.

E. Temperature: One test hourly when air temperature is 40°F and below or 80°F and above, and one test for each composite sample, in accordance with ASTM C1064.

F. Density: Fresh density of sampled concrete; one test for each composite sample, but not less than one test for each day's placement of each concrete mixture, in accordance with ASTM C138.

G. Compression Tests:
   1. Make one set of four cylinders from every load or batch or portion thereof.
   2. Make, cure, store, and deliver cylinders in accordance with ASTM C31.
   3. Mark or tag each set of test cylinders with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump.
   4. Testing Laboratory Will:
      a. Test one cylinder in each set at 7 days.
      b. Test two cylinders from each set at 28 days.
      c. If compressive strength does not reach specified compressive strength at 28 days, test remaining cylinder at 56 days.
      d. Do not test or discard remaining cylinder until so instructed by the Engineer.
      e. Engineer will evaluate in accordance with ACI 214 and 318.
      f. Test in accordance with ASTM C39.
   5. 4" dia. x 8" cylinders may only be used under the following conditions:
      a. Coarse aggregate size for all mixes used on the project do not exceed 1-1/4" maximum size, and
      b. Test cylinders for all mixes used on the project shall be the same size.

H. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive strength tests equals or exceeds specified compressive strength and no compressive strength test value falls below specified compressive strength by more than 500 psi.

I. Concrete used solely for blocking of water line valves or fittings will not require testing. It shall, however, be subject to acceptance by the Engineer as to its suitability.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes shop fabricated metal items:
1. Channel door frames
2. Grating
3. Ledge and shelf angles
4. Lintels
5. Metal Anchorage Mounting Materials and Accessory Items
6. Pipe Bollards
7. Pipe and Tube Handrails, Banister and Fittings
8. Stair nosings
9. Structural supports for miscellaneous attachments
10. Window security grilles

B. Related Sections:
1.

1.02 REFERENCES

A. Aluminum Association:
1. AA DAF-45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:
1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
3. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

C. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
7. ASTM A297/A297M - Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application.
8. ASTM A283/283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
10. ASTM A312/A312M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
11. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
12. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
13. ASTM A479/A479M - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
14. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
15. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
16. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
17. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
18. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
19. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings.
20. ASTM B85 - Standard Specification for Aluminum-Alloy Die Castings.
21. ASTM B177 - Standard Guide for Chromium Electroplating on Steel for Engineering Use.
22. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
23. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
24. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
25. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
26. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

27. ASTM F436 - Standard Specification for Hardened Steel Washers.
28. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

D. American Welding Society:
1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.
3. AWS D1.6 - Structural Welding Code - Stainless Steel.

E. National Ornamental & Miscellaneous Metals Association:
1. NOMMA Guideline 1 - Joint Finishes.

F. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 1 - Solvent Cleaning.
3. SSPC SP 10 - Near-White Blast Cleaning.
4. SSPC Paint 15 - Steel Joist Shop Paint.
5. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

1.03 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

C. Samples: Submit two, inch in size illustrating factory finishes.

D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.04 QUALITY ASSURANCE

A. Finish joints in accordance with NOMMA Guideline 1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept metal fabrications on site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather.

1.06 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel:
1. Steel Sections: ASTM A36/A36M. ASTM A572/A572M; Grade 50.
2. Steel Plate: ASTM A36/A36M. ASTM A572/A572M; Grade 50.
3. Hollow Structural Sections: ASTM A500, Grade B. ASTM A501.
4. Steel Pipe: ASTM A53/A53M, Grade B Schedule 40. .
5. Sheet Steel: ASTM A653/A653M, Grade 33 Structural Quality with galvanized coating.
6. Bolts: ASTM A307; Grade A or B. ASTM A325; Type 1
   a. Finish: Unfinished. Hot dipped galvanized. Mechanically galvanized.
7. Nuts: ASTM A563 heavy hex type.
   a. Finish: Unfinished. Hot dipped galvanized. Mechanically galvanized.
8. Washers: ASTM F436; Type 1.
   a. Finish: Unfinished. Hot dipped galvanized. Mechanically galvanized.
9. Welding Materials: AWS D1.1; type required for materials being welded.
10. Shop and Touch-Up Primer: SSPC Paint 15, Type 1, red oxide.
11. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic Type II Organic zinc rich.

B. Stainless Steel:
1. Bars and Shapes: ASTM A276 ASTM A479/A479M; Type 302 304 316.
2. Tubing: ASTM A269 ASTM A554; Type 304 316.
3. Pipe: ASTM A312/A312M, seamless welded; Type 304 316.
4. Plate, Sheet and Strip: ASTM A167; Type 302 304 316.
5. Bolts, Nuts, and Washers: ASTM A354.
6. Welding Materials: AWS D1.6; type required for materials being welded.

C. Aluminum:
1. Extruded Aluminum: ASTM B221, Alloy 6063, Temper T5.
2. Sheet Aluminum: ASTM B209, Alloy, Temper.
3. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210, Alloy 6063, Temper T6.
4. Aluminum-Alloy Bars: ASTM B211, Alloy 6063, Temper T6.
5. Aluminum-Alloy Sand Castings: ASTM B26/B26M, Alloy.
6. Aluminum-Alloy Die Castings: ASTM B85, Alloy, Temper.
7. Bolts, Nuts, and Washers: Stainless steel. Steel, galvanized.
8. Welding Materials: AWS D1.1; type required for materials being welded.

2.02 CHANNEL DOOR FRAMES

A. Door Frames: Steel channel angle sections, size indicated on Drawings, with jamb anchors suitable for building into masonry attachment to concrete steel framing, minimum 4 anchors per jamb; galvanized. prime paint, one coat.

2.03 GRATING

A. General: Provide grating with similar pattern throughout work.

B. ANSI / NAAMM MBG 531 -Metal Bar Grating Manual.

C. Depth of bearing bars:
1. Suitable to achieve max. deflection of 0.5” at 150 lbs./sq. ft. for actual span.
2. Minimum depth: 1.25”

D. Laid out with openings centered on joint between sections.

E. 3/16” thick, full depth bands at ends of bearing bars in grating floor sections.

F. Weld bands to first, last and every fourth intermediate bearing bar.

G. Cut cross bars flush with outside face of side bars.
1. Cutting:
   a. Angular, circular and re-entrant cuts: Flame cutting in steel.
   b. All other cuts: Sawed or sheared.
   c. Clean and smooth without fins, beads or other projections.

H. Fabricate in easily handled panels.
1. Maximum piece weight: 75 lbs. unless otherwise approved by Engineer.
2. Align cross bars and edge bars of adjacent panels.
3. Maximum clearance between panels: 0.75”
4. Make all bearing bars parallel.
5. Make all grating flat with no tendency to rock.
6. Tolerance:
   a. Length: 3/16” plus or minus.
   b. Width: 1/8” plus or minus.
   c. Max difference or opposite diagonals: 1/4”
   d. Bearing bar spacing: 1/32” plus or minus.
   e. Bend vertical and horizontal alignment: 1/8” plus or minus.
   f. Maximum opening between grating and openings for equipment which extends above top of grating: 2”
   g. Maximum grating opening for stop plates: 2.5”

I. Steel Grating:
1. Hot dipped galvanized after fabrication.

2. Welded or pressure locked.
3. Bearing bars: 3/16” thick minimum at 1-3/16” centers.
4. Straightened after galvanizing.
5. Frames: Hot dipped galvanized steel or aluminum, cast in concrete. Provide approved coating on all aluminum surfaces to be in contact with concrete.

J. Aluminum Grating:
1. Pressure locked type.
2. Treads may be pressure locked or one piece extrusions.
3. Bearing bars: 3/16" minimum flat stock or equivalent I-bars at 1-3/16” centers.

K. Frames: Aluminum, cast in concrete, with approved coating at all surfaces to be in contact with concrete.

L. Stair Treads:
1. With carrier plates and abrasive nosing.
2. Fastened to stringers with stainless steel bolts.

2.04 LEDGE AND SHELF ANGLES

A. Ledge and Shelf Angles, Channels and Plates Not Attached to Structural Framing: For support of metal decking joists masonry; galvanized. Prime paint, one coat.

2.05 LINTELS

A. Lintels: Steel sections, size and configuration as indicated on Drawings, length to allow 8 inches minimum bearing on both sides of opening.
1. Exterior Locations: Galvanized. Prime paint, one coat.
2. Interior Locations: Prime paint, one coat.

2.06 PIPE BOLLARDS

A. Bollards: Steel pipe, concrete filled, crowned cap, 6 inches diameter, length as indicated on Drawings; galvanized - prime paint, one coat.

B. Concrete Fill: 3,000 psi as specified in Section 03 30 00.

C. Anchors: Concealed type as indicated on Drawings.

2.07 PIPE HAND AND GUARD RAILS

A. General: All handrails and guardrails are to have a similar appearance throughout the project.

B. Aluminum:
1. 1-1/2” Schedule 40 pipe railings and Schedule 80 posts, or

2. Clear satin anodized finish all exposed surfaces:
   a. 0.4 mil thickness for cast components.
   b. 0.7 mil thickness for extruded components.

C. Steel:
1. 1-1/2" x-strong pipe posts.
2. 1-1/2" standard pipe rails.

D. Connections:
1. Cope members and continuously weld or connect mechanically at all junctions to provide finished appearance similar to welded system.

E. Sleeves:
1. Fixed posts: Standard weight black steel pipe, 6" minimum diameter to provide 1/4" or larger clearance around post.
2. Removable posts: Standard weight black steel pipe, outer sleeve; Schedule 40 PVC pipe, inner sleeve.

F. Safety Chain:
1. Where indicated on Drawings.
2. 1/4" chain, length as required by opening.
3. Fastened to one post with stainless steel eyebolt.
4. Fastened to other post by a 2-1/2" heavy duty cadmium plated harness strap engaging a similar eyebolt.
5. At every horizontal member.

G. Toe Plates:
1. 1/4" thick.
2. Top 4" above top of walking surface.
3. Not required at stairs.
4. Connected to each post.

2.08 STAIR NOSINGS

A. Manufacturers - Extruded Aluminum:
1. American Stair Tread Model.
2. Balco/Metalines Model.
3. Model.
4. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.

B. Manufacturers - Cast Metal:
1. Wooster Products Inc. Model.
2. Safe T Metal Company; Model.
3. American Safety Tread Co. Inc. Model.
4. Model.
5. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.

C. Stair Nosings: Single piece Two piece extruded aluminum with abrasive surface color as selected, 2 3 4 inches wide x length 6 inches less than stair tread width, integral separate anchors for casting into concrete.

D. Stair Nosings: Cast iron aluminum bronze nickel with abrasive surface, 2 3 4 inches wide x length 6 inches less than stair tread width, integral separate anchors for casting into concrete.

E. Specialty and Accessory Items:
1. Chain: FS RR-C-271, Type I, Grade C, Class 5, Style 2, galvanized; welded steel, twist-link style, short link pattern.
2. Handrail-setting cement where allowed by Engineer: ASTM C595 hydraulic quick setting cement, factory prepared with accelerator.
3. Grating saddle clips and flange block:
   a. ANSI A202.1
   b. Steel grating: Galvanized steel clips.
   c. Aluminum grating: Aluminum or stainless steel clips or blocks.
   d. Clip fasteners: Nelson stud type bolts, 1/4" minimum, galvanized or corrosion resistant alloy.

2.09 STRUCTURAL SUPPORTS

A. Telescopic Steel Columns: Steel, 3 inch diameter, 6 to 9 feet; prime paint, one coat.

B. Joist Hangers: Joist strap anchors, fabricated with gage steel; galvanized. Prime paint, one coat.

C. Toilet Partition Suspension Members: Steel Aluminum channel angle sections; prime paint, one coat mill finish.

D. Other Structural Supports: Steel sections, shape and size as indicated on Drawings required to support applied loads with maximum deflection of 1/240 of the span; prime paint, one coat mill finish.

2.10 WINDOW SECURITY GRILLES

A. Window Security Grilles: Steel, welded construction, conform to shape of window.
1. Verticals: 1/2 inch diameter solid bar, 4 inches on center.
2. Top and Bottom Rail: 1/4 x 1-1/2 inches flat bar, 6 inches from top and bottom.
3. Hinges: Two for each grille, mounted for side swing.
4. Padlock Hasp: Side opposite hinges for securing gates in closed position.
5. Anchors: Fabricate as required for attachment to existing window jambs within window opening. Attachment to exterior building facade, overlapping window opening is not permitted.

6. Finish: Galvanized. Prime paint, one coat. Finish paint.

2.11 ANCHOR BOLTS

A. Anchor Rods: ASTM F1554; Grade 55, weldable. ASTM A307; Grade A.
1. Shape: Hooked. Straight.
2. Furnish with nut and washer; unfinished.

2.12 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by intermittent welds and plastic filler. continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Welded Joints: NOMMA Guideline 1 Joint Finish.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.13 FACTORY APPLIED FINISHES – STEEL

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Prime paint items with one coat two coats except where galvanizing is specified.

D. Galvanizing: ASTM A123/A123M; minimum 1.2 2.0 oz/sq ft coating thickness; galvanize after fabrication.

E. Galvanizing for Fasteners, Connectors, and Anchors:
1. Hot-Dipped Galvanizing: ASTM A153/A153M.
2. Mechanical Galvanizing: ASTM B695; Class 50 minimum.

F. Chrome Plating: ASTM B177, weight, nickel-chromium alloy, satin polished finish.

2.14 FACTORY APPLIED FINISHES - STAINLESS STEEL

A. Satin Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

B. Mirror Polished Finish: Number 8, mirror polish with preliminary directional polish lines removed.

2.15 FACTORY APPLIED FINISHES - ALUMINUM

A. Finish coatings to conform to AAMA 2603 AAMA 2604 AAMA 2605 AAMA 611. Comply with AA DAF-45.

B. Exterior Aluminum Surfaces: AAMA A41 A42 A43 A44 anodized, prepared with mechanical M chemical C pre-treatment, anodized to clear color.

C. Exterior Aluminum Surfaces: Exterior Hardcoat Two step anodized to clear color, to 0.0007 inch thickness Organic coating to color as selected.

D. Interior Aluminum Surfaces: AAMA A41 A42 A43 A44 anodized, prepared with mechanical M chemical C pre-treatment, anodized to clear color.

E. Interior Aluminum Surfaces: Interior Hardcoat Two step anodized to clear color, to 0.0007-inch thickness Organic coating to color as selected.

F. Apply one coat coats of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.16 FABRICATION TOLERANCES

A. Squareness: 1/8 inch maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch.

C. Maximum Misalignment of Adjacent Members: 1/16 inch.

D. Maximum Bow: 1/8 inch in 48 inches.

E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Administrative Requirements: Section 01 30 00 - Coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive Work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where site welding is required.

B. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Make provisions for erection stresses. Install temporary bracing to maintain alignment, until permanent bracing and attachments are installed.

C. Field weld components indicated on Drawings.

D. Perform field welding in accordance with AWS D1.1.

E. Obtain approval of Architect/Engineer prior to site cutting or making adjustments not scheduled.

F. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

G. Handrails:
1. Install with posts plumb and longitudinal members parallel to each other and to floor or slope of stairs.
2. All members in a section in true alignment with the same vertical plane.
3. Install posts with wall brackets unless otherwise indicated or required:
   a. Anchor brackets with two stainless steel bolts and expansion anchors and anchor posts in brackets with two stainless steel bolts through post and bracket.
4. Attach fixed handrail posts to supporting structure:
   a. Set in sleeves only where specifically indicated on Drawings.
   b. Support sleeves in accurate alignment in forms.
   c. Sleeve held below the finished concrete surface.

d. Measure the location of each sleeve before fabricating handrail.
e. Wedge post in accurate alignment and fill annular space and post to level of weep hole with handrail-setting cement.
f. Top surface of cement smooth finish and sloping away from post.
g. Where indicated, attach to structure with flanges and other special attachments or anchorages.

5. Removable sections: In double sleeves:
   a. Inner sleeve in outer sleeve as specified for fixed posts.
6. Field connections: Locking mechanical splice fittings.
7. Slip joints for expansion and contraction:
   a. 30’ max. intervals.
   b. Gap: Between 1/8” and 3/8”.
8. Post spacing:
   a. Aluminum: 5’ max.
9. Provide weep holes in all embedded posts and in any railing where water will not otherwise drain.
10. Coordinate handrails and installation so maximum clear opening between non-connected handrail sections, or handrails and equipment or structures where handrails end at such, is 8”.
11. Install toe plates so maximum opening between plate and floor/structure is 0.38”.

3.04 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation from Plumb: 1/4 inch per story or for every 12 ft in height whichever is greater, non-cumulative.

C. Maximum Offset From Alignment: 1/4 inch.

D. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 50 00

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SECTION 05 50 01

ANCHOR BOLTS AND CHEMICAL ANCHORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cast-in anchor bolts for structural connections and to secure equipment.

B. Bolts, threaded rods, and deformed rods to be placed in holes drilled into hardened concrete or masonry and secured by chemical grouts.

1.02 SUBMITTALS

A. Section 01 33 23: Shop Drawings, Product Data, and Samples

B. Product Data

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver anchor bolts and templates in time to permit setting when structural concrete is placed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bolts:
1. Carbon steel: ASTM A 307
2. Galvanized steel: Carbon steel, hot-dip galvanized, ASTM A 153; or zinc plated, ASTM A 164, type GS
3. Stainless steel: ASTM F 593

B. Nuts:
1. Same material as bolts.
2. Carbon steel: ASTM A 563, Grade B heavy hexagonal
3. Stainless steel: ASTM F 594
4. Self-locking: Prevailing torque, IFI-100, Grade A

C. Washers:
1. Same material as bolts.
2. Flat: ASTM F 436
3. Locking: Spring type ANSI B27.1

D. Sleeves:
1. Pipe: ASTM A 53, galvanized
2. Bearing plates: ASTM A 36, galvanized

E. Chemical Anchor Systems:
1. Fastener or connector: Bolt, threaded rod or deformed rod as shown on Drawings, material as indicated on Drawings or specified.
2. Screen sleeves: For attachment to hollow masonry walls, provide stainless steel screen sleeves specifically manufactured for the purpose and approved by the manufacturer of the adhesive to be used.
3. Chemical adhesive: Two component system to be mixed at the site and placed into predrilled holes.
4. Acceptable products: Subject to compliance with the requirements of these specifications, products which may be used in the work include, but are not limited to, the following:
   a. Epcon Epoxy Injection System as manufactured by ITW Ramset/Red Head.
   b. HIT Renovation Anchor System as manufactured by the HILTI Corporation.
   c. Molly PARAFAST Resin Mortar as manufactured by the Molly Fastening Systems Group of Emhart Corporation.

2.02 FABRICATION AND MANUFACTURE

A. Anchor Bolts:
1. 3/4” minimum, except as indicated on the Drawings.
2. Type:
   a. General use: L-shaped hook type.
   b. Where indicated on Drawings or specified:
      1) Straight bolt with square head.
      2) Straight bolt with square plate welded to bolt and nut welded to plate and bolt.
      3) Through-bolt with sleeve and square plate assembly.
      4) Coupled bolt with sleeve welded to square plate and bolt.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that holes for anchor bolts in forms and templates match applicable equipment shop drawings.

3.02 INSTALLATION

A. Anchor Bolts:
   1. Where installed in cast-in-place concrete, install a nut on the concrete side of the form or supporting template.
   2. Provide 3 nuts for each equipment anchor bolt for which a lock nut is indicated, 2 for others.
   3. Sleeved anchor bolts:
      a. Centered in pipe sleeve.
      b. Sleeve ID: Approximately 2-1/2 times bolt OD.
      c. Sleeve length: Approximately 8 times bolt OD.
      d. Bearing plate minimum thickness: 1/2 times bolt OD.
   4. Through bolts:
      a. Sleeved with bearing plates.
      b. Bearing plates welded to bolt and plate welded to sleeve.
      c. Dimension: As specified for sleeved anchor bolts.

B. Chemical Anchor Systems:
   1. Install in conformity with the manufacturer's instructions.

3.03 SCHEDULE

A. Anchor bolts to be Type 316 stainless steel unless noted otherwise on Drawings.

B. All sleeves and plates galvanized unless noted otherwise on Drawings.

C. Wedge anchors not acceptable unless noted otherwise on Drawings.

END OF SECTION

SECTION 09 97 01

INDUSTRIAL COATINGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, tools, scaffolding, and paint for:
1. Exposed piping, valves, fittings, and other metal surfaces, interior and exterior.
2. Submerged metal surfaces.
3. Structural and miscellaneous steel, including tanks and wet wells.
4. Exterior above-ground concrete and masonry to 6” below ground level.
5. Interior of concrete structures.
6. Equipment furnished without factory finished surfaces.
7. Ferrous metal portions of slide gate and valve pedestals and operators.
8. All other surfaces requiring protection.

B. Recoat, or touch-up, all equipment furnished with factory coatings which are damaged, scratched, or rusted during shipping, storage, or installation. Recoating to match original finish, quality, and appearance.

C. Refer to Section 40 27 01 – Identification Systems for Pipe, Valves, and Gates, for additional requirements for painting piping.

1.02 WORK EXCLUDED

A. Architectural painting specified in Section 09 90 00 – Painting and Coating.

B. The following materials, items, and areas shall not be painted under this contract, except as noted:
1. Surfaces of glass, china, ceramic tile vitreous enamel, chrome-plating, rubber, stainless steel, aluminum, fiberglass plastic, and galvanized metal, except as indicated on Drawings.
2. Non-ferrous insulation jackets.
3. Concealed interior surfaces of concrete block.
4. Concealed ductwork, piping, and conduit.
5. Insulated metal ductwork.
6. Lubrication fittings, valve stems, shafting float rods, nameplates and instruments.
7. Cast iron outdoor manhole covers, and cast iron outdoor manhole cover frames.
8. Contact surfaces of rails and machined surfaces of equipment.

C. The following items have either factory-applied permanent finishes or have been finish painted by others, and shall not be painted under this contract.
1. HVAC equipment specified under Division 23.
2. Electrical equipment specified under Divisions 26 and 40.

1.03 REFERENCES

A. The Society for Protective Coatings (formerly Steel Structures Painting Council - SSPC):
   1. Steel Structures Painting Manual Vol. 2: Systems and Specifications.
   2. SSPC-SP 1: Surface Preparation Method – Solvent Cleaning.
   3. SSPC-SP 2: Surface Preparation Method – Hand Tool Cleaning.
   4. SSPC-SP 6/NACE No. 3: Surface Preparation Method – Commercial Blast Cleaning.
   5. SSPC-SP 7/NACE No. 4: Surface Preparation Method – Brush-off Blast Cleaning.
   6. SSPC-SP 10/NACE No. 2: Surface Preparation Method – Near-White Metal Blast.
   7. SSPC-SP 13/NACE No. 6: Surface Preparation of Concrete.

B. American Society for Testing Materials International (ASTM):
   1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
   2. ASTM D522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
   3. ASTM D610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces.
   4. ASTM D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   5. ASTM D4258 – Standard Practice for Surface Cleaning Concrete for Coating.
   6. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
   7. ASTM D4787 – Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
   8. ASTM D7234 – Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.

C. National Association of Corrosion Engineers International (NACE):
   1. NACE SP0188 – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
   2. NACE SP0288 – Inspection of Lining Application in Steel and Concrete Equipment.

D. American National Standards Institute (ANSI):
   1. ANSI/ASME A13.1 – Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS

A. Product Data: Section 01 33 23 – Shop Drawings, Product Data, and Samples.

B. Schedule of products to be used and mil thicknesses to be applied in accordance with manufacturer’s recommendations.

C. Manufacturer's standard color selection charts. Engineer will use charts to select colors of industrial coatings.

D. Coatings submitted as a substitution for the specified coating under each Service Condition shall include proof of equivalency to the specified coating. The equivalency data shall be submitted in tabular form and shall be as follows:

	Brand X	Brand Specified
Product		
Theoretical coverage rate		
Recommended wet and dry film thickness		
Pot life		
Shelf life		
% solids		
% VOC or solvent		
Any additional requirement for surface preparation beyond those specified		
Recommended temperature range for application		
Curing time		
Curing agent		
For Service Conditions C1, C2, C3, C4, F1, or F2 also include data for:		
ASTM B117 Salt fog resistance		
ASTM D522 Flexibility		
ASTM D4060 Abrasion Resistance		

Submission of the equivalency data in any other format, or incomplete information, will be cause for rejection by the Engineer.

1.05 ADDITIONAL REQUIREMENTS

A. Workmanship:
   1. Work to be done by skilled craftsmen in a manner comparable with the best standards of practice found in each trade.
   2. Applicable surface preparation, coating and painting to conform with the requirements of the SSPC Steel Structures Painting Manual.
   3. Contractor to provide a resident supervisor during cleaning and coating operations.
   4. All coating and painting equipment to be suitable for each specific material being applied and kept in first class working condition at all times.
      a. Compressors to have suitable traps and filters installed.
      b. All equipment to be subject to Engineer's and/or paint manufacturer's approval.

B. Surface Preparation:
   1. Evaluated as compared with SSPC-VIS 1 and SSPC-VIS 2 (ASTM D610).
   2. Surfaces with grease to be hot detergent washed and rinsed as necessary prior to sandblasting and/or painting.
   3. Type-Sandblasting Test: Standard metal plates of 8-1/2" x 11".
   4. Plates to be prepared for each type sandblasting specified.
   5. Concrete surfaces to receive Service Condition C1, C2, C3, or C4, coatings: Prepared to have a clean surface, free of form release agents, laitance, or other contaminants, and having a rough profile equal to that of medium grit sandpaper.
   6. Any material applied upon improperly prepared surfaces will be removed and redone to the satisfaction of the Engineer at the sole expense of the Contractor.

C. Environmental Requirements:
   1. Contractor responsibilities include:
      a. Ensuring that coating work only occurs when environmental conditions comply with manufacturer's written requirements for same.
      b. Continuously monitoring air and substrate temperatures and relative humidity to determine acceptability of environmental conditions and maintaining written logs for same which are available for Owner or Engineer's inspection.
      c. Furnishing temporary environmental controls as needed to meet manufacturer's environmental requirements.
      d. Preventing contamination of painted surfaces by adequate means.
      e. Cleaning, washing, and recoating of areas which become contaminated with dirt, dust, or foreign material at no additional cost to Owner.
      f. Anticipating when unfavorable environmental conditions are likely to occur, e.g., time of day when condensation occurs, and scheduling coating work around such times.
      g. Providing a minimum of 70 foot-candles of illumination in work areas when performing Service Condition C1, C3, or F1 coating work.

2. Do not apply coatings during the following conditions:
    a. Air or substrate temperature measured in the shade is less than manufacturer's written minimum required temperature.
    b. Surface to be coated is wet, damp, or has condensation present.
    c. During rain, snowfall, mist, or when relative humidity exceeds manufacturer's written recommendations or within 18 hours of such conditions occurring.
    d. During dust storms.
3. Suspend coating application whenever dew or moist conditions are present; do not resume until such conditions improve.
4. Complete coating work in advance of time of day when condensation occurs.
5. Contractor's efforts to fulfill environmental requirements as described are considered incidental work and no separate payment will be made therefor.

D. Inspection:
1. Concrete and non-ferrous metal, surfaces to be manually inspected with approved wet film thickness gauge.
2. Ferrous metal surfaces to be mechanically inspected with approved dry film thickness gauge.
3. Ferrous metals under System F1 and concrete under System C2 to be electrically inspected with approved holiday detector.
4. Concrete under System C2 to be tested for bond strength using specified procedure.
5. Insufficient or defective areas: Rework as necessary.

E. Thickness Checking:
1. Thickness on ferrous metals to be checked with a non-destructive, magnetic type gauge in conformance with SSPC – PA 2 – Measurement of Dry Film Thickness with Magnetic Gages.
2. Thickness on concrete surfaces to be tested with a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 shall be used to ensure a monolithic lining and uniform thickness during application.

F. Acceptable Thickness Inspection Devices:
1. Tinker-Rasor Models: AP and AP-N.
2. Tinker-Rasor Model M-1 6/ 1/2 volt.
3. Microtest units for dry-film thickness gauging.
4. Inspection devices to be operated as recommended by the manufacturer.
5. Devices and calibration plates furnished by the Contractor to be certified by the U.S. Department of Commerce, National Institute of Standards and Technology.
6. Devices to be supplied by Contractor at no additional cost to Owner and to be on project site whenever coatings are being applied.

G. Holiday Testing:
1. Tested with an approved holiday detection unit in accordance with one of the following standards:
   a. Conductive Substrates: NACE SP0188.
   b. Concrete Substrates: ASTM D 4787.
2. After the coating has set hard to the touch, inspect for continuity and pinholes with high-voltage holiday detection equipment (spark tester).
3. An induced holiday shall be made on the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area.
4. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied and may be adjusted as necessary to detect the induced holiday.
5. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method.
6. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

H. Bond Strength Testing:
1. Measurement of the bond strength of the protective coating to the substrate shall be made by coating one smooth faced cement masonry unit block for each wall where bond strength inspection is required. Each block shall be coated at the same time and in the same manner as the surface it represents and cured inside the structure.
2. Bond (adhesion) strength of coating on concrete shall be measured in accordance with ASTM D 7234.
3. Any areas detected to have inadequate (less than 300 psi to concrete) bond strength may be rejected, as evaluated by the Engineer.
4. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor in strict accordance with manufacturer's recommendations.

1.06 DELIVERY AND HANDLING

A. All materials to be brought to the site in the original sealed containers.

B. Containers to be open or used only after Engineer's inspection for contents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products specified herein.

B. Substitutions considered only if:
   1. Engineer has reviewed and taken no exceptions to Contractor's proof of equivalency data submitted per paragraph 1.04.D.
   2. The substitute coating has a substantiated five-year record on projects of similar nature.

C. All coating materials shall be VOC compliant in accordance with the latest version of EPA regulations 40 CFR Part 59 Subpart D – National Volatile Organic Compound Emission Standards for Architectural Coatings. All coating materials shall be certified lead and chromate free.

D. Paint and coatings for equipment shall not conflict with equipment manufacturer's recommendations.

E. Field-applied coatings shall be compatible with shop primer furnished by others.

2.02 BLAST MEDIA

A. Media for sandblasting operations: Copper slag, or other media, free of clays or other contaminants and which has sharp irregular edges and particle size gradation to produce an anchor profile in accordance with coating manufacturer's recommendations.

B. Re-use of blast media is prohibited without the Engineer's written authorization.

2.03 SERVICE CONDITIONS: See Tables at end of this Section.

2.04 MAINTENANCE MATERIALS

A. All unused single component paint and coatings in partially used containers remaining from work.

B. Not less than 1% of all single component paint and coatings used in work; resealed partially used containers can be used to meet this requirement.

PART 3 EXECUTION

3.01 GENERAL

A. Sandblasting and priming to be completed on any particular area within the period of an eight-hour working day.

B. Primer application shall follow immediately after surface preparation and prior to any sign of corrosion.

C. Surfaces not primed right after preparation within the eight-hour working period shall be re-prepared before primer application.

D. Prior to final and unchangeable assembly, all surfaces shall be finished to the full satisfaction of the Engineer.

3.02 SURFACE PREPARATION

A. Field blast cleaning for all surfaces: Dry sandblasting method unless otherwise directed.

B. Existing facilities or finished coatings to be protected from sandblasting at all times.

C. Cleaning of the sandblasting area: Section 01 74 00 – Cleaning and Waste Management.

D. Prior to application of coatings: Dry clean sandblasted surfaces.

E. Welds to be neutralized with a suitable solvent compatible with the specified coating material.

F. Prepare steel surfaces which are to receive Service Condition F1 or F2 coatings as follows:
   1. Verify that the substrate:
      a. Is free of all surface imperfections such as delaminations, scabs, slag, and slivers.
      b. Has had all sharp edges ground smooth to a minimum of 1/8-inch radius.
      c. Has had all rough welds ground to a smooth surface.
   2. If the steel to be coated will be permanently or intermittently submerged, or permanently subjected to corrosive atmosphere then, also verify that all seams between plates or structural shapes have been permanently sealed from moisture by either continuous welding of seams, or placement of 100% solids epoxy filler in all seams which have not been welded, or another equivalent method of sealing all seams from moisture as reviewed by the Engineer.
   3. Coordinate with the manufacturer of the item to be coated and with other trades as required to correct any deviations from the conditions listed above before starting field blasting or coating operations.
   4. Degrease steel before sandblasting using organic solvents, steam, or hot water with detergents in accordance with SSPC – SP1 – Solvent Cleaning.
   5. Remove trace grit or dust with a clean brush or vacuum cleaner.
   6. Maintain surface temperature in accordance with manufacturer's written recommendations, but at least 5ºF above dew point, throughout surface preparation procedures.

3.03 APPLICATION

A. Notify Engineer immediately after surface preparation and before commencement of coating operations of each large piece of the work.

B. Starting work in a specific area shall be construed as acceptance of the surfaces, and thereafter, the Contractor shall be fully responsible for satisfactory work as required herein.

C. All materials to be applied as recommended by their respective manufacturer.
   1. Recoat epoxy coatings within time limit specified by manufacturer. If time limit is exceeded, prepare epoxy surface as recommended by manufacturer, using such techniques as brush-off blasting to achieve the recommended surface profile.

D. Each application of paint or coating to be:
   1. Applied at the proper consistency.
   2. Free of brush marks, sags, runs or evidence of poor workmanship.
   3. Avoid lapping on glass or hardware.
   4. Finished surfaces shall be free from defects or blemishes.

E. Use protective coverings or drop cloths for floors, fixtures, and equipment.

F. Whenever two or more coats of a dark colored paint or coating are specified, coats must be of variable color.

G. All welds and irregular surfaces shall receive a brush coat prior to, and in addition to, application of the first complete specified coat.

3.04 CLEANUP

A. Section 01 74 00 – Cleaning and Waste Management.

B. All spilled or splattered paint shall be cleaned up immediately.

C. All sandblasting media shall be cleaned up and disposed of properly off-site at Contractor's expense.

D. All discarded materials shall be disposed of properly off-site at Contractor's expense.

3.05 TABLE OF SERVICE CONDITIONS - SEE PAGES WHICH FOLLOW

3.06 SCHEDULE OF SURFACES TO RECEIVE INDUSTRIAL COATINGS

A. Abajo Lift Station, Valve Vault, Meter Vault:

Surface	Coatings with Service Conditions	Notes
1. All interior vertical wall surfaces and underside of top in wet well and valve vault.	C2	Prepare existing surfaces of concrete down to sound substrate. Holiday Test. Bond Test.
2. Exterior below grade surfaces of wet well and valve vault.	C6	

B. Process Equipment, Piping, and Appurtenances:

Surface	Coatings with Service Conditions	Notes
1. All ferrous metal inside tank and basin structures and not galvanized.	F1	Coatings shall be absolutely continuous.
2. Ductile iron piping inside wet well.	F1	Coatings shall be absolutely continuous.
3. All interior and exterior ferrous metal without factory top coat and not exposed to submergence.	F4	
4. Ductile iron pipe and castings with factory asphaltic coating and requiring a field colored top coat.	F7	
5. All structural steel except galvanized.	F4	
6. Galvanized structural steel.	M1	
7. Exposed PVC piping.	M2	

C. Sanitary Sewer Manholes: Refer to Specification 33 05 61 – Sanitary Sewage Manholes, Frames, and Covers.

D. Precast Concrete Wet Wells: Refer to Specification 33 05 63 – Precast Concrete Wet Wells.

SECTION 09 97 01
TABLE OF SERVICE CONDITIONS FOR INDUSTRIAL COATINGS

DFT: Dry Film Thickness, mils
WFT: Wet Film Thickness, mils

Condition	Surface Data	Manufacturer	Prime Coat		Intermediate Coat		Finish Coats		Remarks
			Product	Mils	Product	Mils	Product	Mils	
C2	Surface Concrete subject to submergence in sewage, scum, sludge or other highly corrosive liquid (where scheduled).	Zebron	Tnemec Series 215 Surfacing Epoxy applied by trowel or putty knife to fill large holes and bug holes.	---	Zebron Low Temperature Epoxy Primer (ZLTE)	1-3 DFT	Zebron #386 Polyurethane Lining	125 DFT	Holiday Test, Bond Test
		Raven	Optional – Raven 175, Raven 171FS, or Raven 155.	---	---	---	Raven 405	250 DFT	Holiday Test, Bond Test
	Surface Preparation Method Remove all oil and grease per ASTM D4258, followed by brush-off blasting per SSPC-SP13.	Carboline	Carboguard 510 SG spray-grade epoxy modified cementitious mortar applied by trowel to fill large holes and bug holes.	---	Carboline Phenoline 311	2-3 DFT	Reactamine 760 HB Polyurethane Hybrid Lining	125 DFT	Holiday Test, Bond Test
		Tnemec	Tnemec Series 215 Surfacing Epoxy applied by trowel or putty knife to fill large holes and bug holes.	---	Series 201 Epoxoprime	4-8 DFT	Series 436 Perma-Shield FR Fiber-Reinforced Epoxy	100 DFT	Holiday Test, Bond Test
		Or Engineer reviewed substitute.							
	Remove all oil and grease per ASTM D4258, followed by brush-off blasting per SSPC-SP13.								
		Carboline	Carboguard 510 SG spray-grade epoxy modified cementitious mortar applied by trowel to fill large holes and bug holes.	---	Carboguard 61	4-6 DFT	Carboguard 61	4-6 DFT (per coat)	Same as above. Apply two (2) finish coats.
		Or Engineer reviewed substitute.							
C6	Surface Exterior, below grade concrete surfaces requiring damp-proof barrier to moisture.	Tnemec	H.B. Tnemecol Coal Tar Series 46-465	8-12 DFT	---	---	H.B. Tnemecol Coal Tar Series 46-465	8-12 DFT	---
	Surface Preparation Method Remove all oil and grease per ASTM D4258	Sherwin Williams	Targuard Coal Tar Epoxy, B69-60	8-16 DFT	---	---	Targuard Coal Tar Epoxy, B69-60	8-16 DFT	---
		Carboline		---	---	---	Bitumastic 50 Coal Tar	12-20 DFT	---
		Or Engineer reviewed substitute.							

DFT: Dry Film Thickness, mils
WFT: Wet Film Thickness, mils

F1	Surface Ferrous metals permanently or intermittently submerged in sewage or similar corrosive liquid.	Tnemec	Series 446 Perma-Shield MCU	5-7 DFT	---	---	Series 446 Perma-Shield MCU	5-7 DFT	Total system shall not be less than 10 mils DFT at any spot. Coating shall be absolutely continuous.
	Surface Preparation Method SSPC-SP10: Near white metal blast cleaning.	Sherwin Williams	Sher-Glass FF Reinforced Epoxy, B62-525	8-20 DFT	---	---	Sher-Glass FF Reinforced Epoxy, B62-525	8-20 DFT	Coating shall be absolutely continuous.
		Carboline	Carboguard 60 Epoxy Primer	4-6 DFT	---	---	Bitumastic 300M	16-20 DFT	Same as above.
		Or Engineer reviewed substitute.							
F4	Surface Ferrous metals subject to corrosive moisture, incidental splash, atmosphere or condensation, but not subject to submergence.	Tnemec	Series 90-97 Tneme-Zinc	3.0 DFT	Series N69 Epoxoline II	4.0 DFT	Series 1074 Endura-Shield Polyurethane	3.0 DFT	---
	Surface Preparation Method SSPC-SP6: Commercial blast cleaning	Sherwin Williams	Corothane 1 Galvapac Two Pack Zinc Primer, B65	3-4 DFT	Macropoxy 646 Fast Cure Epoxy, B58-600	6-10 DFT	Hi-Solids Polyurethane B65	3.0-4.0 DFT	---
		Carboline	Carbozinc 859 Organic Zinc-Rich Coating	3-4 DFT	Carboguard 890 High-Build Epoxy	4-6 DFT	Carbothane 134 HG Aliphatic Acrylic Polyurethane	2-3 DFT	---
		Or Engineer reviewed substitute.							

F7	Surface Metals finished with coal tar or other bleeding type finish	Tnemec	Series 1029 Enduratone Water-Based Acrylic	4.0 DFT		---	---	---	Intermediate and finish coat as specified elsewhere
	Surface Preparation Method SSPC-SP1: Solvent Clean	Sherwin Williams	0 VOC Acrylic, B66-600	2.5-4.0 DFT	---	---	---	---	See above.
		Carboline	Sanitile 120 Primer	1-2 DFT	---	---	---	---	See above.
		Or Engineer reviewed substitute.							

DFT: Dry Film Thickness, mils
WFT: Wet Film Thickness, mils

M1	Surface Galvanized metal surfaces	Tnemec	Series 6 Tneme-Cryl	2.0-3.0 DFT	---	---	Series 6 Tneme-Cryl	2.0-3.0 DFT	Total system film thickness shall not be less than 4.0 mils DFT.
		Sherwin Williams	Galvite HS, B50WZ30	2-3 DFT	---	---	0 VOC Acrylic, B66-600	2.5-4.0 DFT	Same as above.
	Surface Preparation Method SSPC-SP1: Solvent cleaning	Carboline	Galoseal WB	0.75-1.5 DFT	---	---	Carbocrylic 3359	2-3 DFT	Same as above.
		Or Engineer reviewed substitute.							

M2	Surface Colored coatings for PVC exposed to sunlight, not submerged.	Tnemec	Series 1029 EnduraTone Acrylic Polymer	2-3 DFT	---	---	Series 1029 EnduraTone Acrylic Polymer	2-3 DFT	---
	Surface Preparation Method Roughen with 120 grit sandpaper, followed by SSPC-SP1 solvent cleaning with MEK.	Sherwin Williams	DTM Bonding Primer, B66 A50	2-5 DFT	---	---	DTM Acrylic Coating, B66-200	2-4 DFT	---
		Carboline	Sanitile 120 Acrylic Bonding Primer	1-2 DFT	---	---	Sanitile 155 Acrylic Enamel	2-3 DFT	---
		Or Engineer reviewed substitute.							

END OF SECTION

SECTION 26 00 10

GENERAL CONDITIONS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Labor, equipment, tools, materials, supplies, and operations necessary to install a complete electrical system, including that which may be reasonably implied on the Drawings or in the Specifications as being incidental to the work of Division 26.

B. Labor, equipment, tools, materials, supplies, and operations required to make a completely electrically operable system of the equipment furnished under other Divisions of this Specification.

1.02 MISCELLANEOUS MATERIALS

A. The Drawings are not intended to and do not show all equipment such as junction boxes, outlet boxes, conduit, fittings, mounting and miscellaneous hardware, and similar. Even though such items may not be specifically mentioned in the Specifications nor shown on the Drawings, nor noted on Shop Drawings, if they are necessary to make a complete installation, include them in the work required under this Division.

1.03 QUALITY ASSURANCE

A. Use only thoroughly trained and experienced personnel who are completely familiar with the requirements of this work and with the recommendations of the manufacturer of the specified items to fabricate, install, and test the work of this Division.

B. Where the Specifications or Drawings call for equipment or methods to be of better quality or higher standards than required by referenced Codes or Standards, the Specifications and Drawings shall prevail.

1.04 SUBSTITUTIONS

A. When requesting substitution of material for products specified in this Division, comply with Section 01 25 00 – Substitution Procedures. Include as part of the request detailed descriptions and Drawings showing all resultant changes to the electrical work.

B. The design of certain equipment may be related to factors not immediately obvious. Changes in design of equipment may require technical justification, or require changes be made in other equipment to match the proposed changes, or require the equipment be supplied as specified, or any combination of the above, at no additional cost to the Owner.

1.05 LOCATION OF ELECTRIC EQUIPMENT

A. The Drawings or other Specification Sections define the approximate location of services, cabinets, panelboards, switches, lights, receptacles, and other equipment. Determine the most suitable location by actual measurement during construction. Maintain clearance required by NEC Article 110. Propose final location and obtain approval of the Engineer in advance of installation.

B. Coordinate location and configuration of electrical work with the work of other trades to avoid interference, to assure convenient access for operation and maintenance of equipment, for optimum luminaire placement, and for neat appearance.

1.06 SIZE AND RATING OF MATERIALS

A. The size and rating of the conductors, conduits, overcurrent protection devices, disconnect devices, motor starters, and other related equipment used to provide and control electric supply to the various power consuming equipment furnished under this contract have been determined based on the requirements of the specified equipment. If the requirements of the power consuming equipment actually furnished causes a need to change the rating of any of these materials:
   1. Consult with the Engineer to determine the changes necessary to provide and control electric supply to the equipment furnished, and
   2. Install the agreed upon materials at no increase in the Contract amount or time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26 00 20

CODES, PERMITS, AND FINES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 COMPLIANCE

A. This Section applies to Division 26 and to Division 40 Section 40 61 13 – Control System Documents and Procedures and to Sections referenced therein.

B. Perform Electrical Work and provide material and equipment in compliance with the State of New Mexico Electrical Code (NMEC) NMAC, Title 14, Chapter 10, Part 4 and other national, state, and local codes, regulations, laws, and ordinances. It will be the responsibility of the Engineer to resolve conflicts between the above and the Specifications or the Drawings.

C. Without relieving the Contractor from the obligation to comply with all provisions of the NMEC and other codes and standards, attention is directed to NMAC 14.10.4.11 B. (1) "Section 110.2 Approval." Approval by the Engineer is required for all electrical wiring, equipment or material for which a (UL) safety standard does not exist.

1.02 PERMITS

A. Obtain electrical permits. This applies whether or not the Authority Having Jurisdiction (AHJ) requires a permit for the structural/process portion of a project.

1.03 INSPECTIONS AND CERTIFICATES

A. Arrange and pay for electrical inspections.

B. Correct deficiencies noted as a result of inspections then arrange for additional inspections.

C. Furnish properly executed certificates of final electrical inspection and approval from the AHJ at the conclusion of the work and before final acceptance of the Work by the Owner.

D. It is recognized that inspection by the AHJ is intended to determine whether the Work is in compliance with applicable codes, not to determine whether the Work is in compliance with the Contract Documents.

1.04 PAYMENTS TO THE AHJ

A. Include in the Bid the cost of permits and initial inspections.

B. No change in the Contract Amount will be allowed for other costs associated with this Section, such as but not limited to the cost for certification of non-labeled equipment, additional inspections, and fines/penalties levied by the AHJ. Exception: If a Change Order results in charges from the AHJ for an additional permit and/or additional inspections, then itemized, documented costs will be included in the Change Order amount.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26 00 40

PROJECT RECORD DOCUMENTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. Except as may be stated below, this Section applies to Division 26, to Section 40 61 13 – Control System Documents and Procedures and to Sections referenced therein. It contains minimum requirements; and also complies with Section 01 78 39 – Project Record Documents.

1.02 LEGIBILITY

A. Materials that are not sufficiently legible to the Engineer may be returned without being reviewed.

B. Materials of marginal legibility may be accepted for preliminary review but rejected for use as final Record Documents.

C. Minimum text height on project-specific Submittal Drawings such as schematics, connection diagrams, loop diagrams, and similar: 1/8 inch.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONTRACT DRAWINGS

A. Maintain a complete set of Contract Drawings in "Record" condition. Mark, initial, and date changes, modifications, or corrections as they occur.

B. Show by dimensions and by correct scale the location and burial depth of underground conduits, duct banks, conduit stub outs, and direct buried cables. Show location and depth at each end and at every bend.

C. Show all differences between electrical and instrumentation design and the actual construction of electrical and instrumentation systems.

D. Have the Drawings available for inspection by the Engineer during standard work hours at the project site.

E. Furnish the "Record" Contract Drawings to the Engineer after completing the work and tests.

3.02 RECORD DRAWINGS/SUBMITTALS

A. Maintain a complete set of Shop Drawings in "Record" condition. Mark, initial and date changes, modifications, or corrections as they occur.

B. Where required in the equipment sections, return field marked Shop Drawings to the respective manufacturer who shall transfer "Record" markings to the original tracings, stamp the originals "Record" and place the date adjacent to the stamp.

C. Where a connection diagram is required as part of the submittals for a Section of these Specifications, whether in Division 26 or Division 40 or not, the Record documents for that section shall include copies of the connection diagrams that show all field interconnection information. Where a wire goes to a field device, such as a STOP pushbutton, the interconnection information may simply read "STOP pushbutton, field." Where a wire goes to an equipment where it is terminated on a terminal board, show the wire destination by equipment name or abbreviation, then terminal board number, then terminal point number, VFD1-B 6 for example.

D. Furnish other "Record" Shop Drawings to the Engineer.

END OF SECTION

SECTION 26 00 60

EXTRA MATERIALS AND SPARES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Extra materials, such as spare parts, maintenance materials, and special tools for Division 26, Section 40 61 13 – Control System Documents and Procedures, for Sections referenced therein, and for other Sections as required below.

B. Marking, packaging, and delivery of extra materials as required in Division 1.

1.02 SUBMITTALS

A. Include detailed descriptions of extra materials in the submittal materials for specific Sections and show in the Master List as required in Section 01 78 44 – Spare Parts and Maintenance Materials.

PART 2 PRODUCTS

2.01 EXTRA MATERIALS AND SPARES REQUIRED

A. If the equipment submitted differs from that specified and the manufacturer recommends extra materials, provide extra materials of equal function to those specified. Also provide additional materials if so recommended in the manufacturer's Operation and Maintenance Manual. Information on all additional materials and substituted materials shall be properly submitted to the Engineer for approval before materials are purchased.

B. Regardless of the Division/Section in which the equipment is specified, provide spares of every type and rating of fuse used in the project. Provide minimum quantity as shown below but provide more if so specified elsewhere.
   1. Fuses of 250V or Less:
      a. One standard package or ten, whichever is greater.
   2. 600V Fuses:
      a. Six.

C. Regardless of the Division/Section in which the equipment is specified, provide minimum quantity of spares as shown below but provide more if specified elsewhere.
   1. Network Ethernet Switch:
      a. One spare.
   2. Programmable Logic Controller (PLC) Power Supply Card or Module:
      a. One spare.

3. Fiber Optic Cable Tester:
    a. One.
4. A-B 5380 PLC CPU:
    a. One.
5. A-B 5069 I/O modules:
    a. One of each type used on project.
6. As required in specific Sections.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE WIRE AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low voltage wire and cable.

1.02 SYSTEM DESCRIPTION

A. Furnish wire and cable for all systems except:
1. Where supplied as part of an equipment or system.
2. Where specifically stated otherwise in other parts of the Specifications or on the Drawings.

B. Install, connect, mark, and test all wire and cable.

1.03 SUBMITTALS

A. Manufacturer's standard literature.

PART 2 PRODUCTS

2.01 600V POWER AND GENERAL-PURPOSE WIRE (COPPER)

A. Meet NEC 310, UL 83, and the ANSI C8 Series.

B. Conductor: Copper.

C. NEC Type: THWN/THHN.

D. Minimum wire size unless specifically noted otherwise on the Drawings:
1. 480V: #10 AWG.
2. 120/208/240V: #12 AWG.
3. Control: #14 AWG, stranded.
4. Grounding/bonding conductors: #12, except #14 for control runs.

2.02 SHIELDED CABLE (TWSH)

A. 90°C operation.

B. Stranded bare or tinned copper, #18 AWG with 300V insulation, meet NEC 336.

C. Insulation: Extruded PE, PVC, or PVC/Nylon.

D. Conductor Identification: Colored pairs.

E. Pair Construction: Twisted pair, lay 1-1/2″ to 2-1/2″.

F. Core Tape: Polyester with 25% overlap.

G. Shield: Polyester supported aluminum tape with tinned #20 AWG copper drain wire.

H. Jacket: Ultraviolet stabilized, flame retardant extruded black PVC with non-hygroscopic rip cord.

I. Triad cable shall be Belden 1036A, pair cable shall be Belden 9460 or Engineer reviewed equivalent.

2.03 TRAY CABLE (TC)

A. Meet NEC 336, 50l, 725, 727, and 760. UL listed as Type TC. UL listed as suitable for direct burial in sizes #l4 AWG and larger.

B. Flame, moisture, and sunlight resistant. Meet UL 1581 Vertical Tray Flame Test at 70,000 BTU.

C. Ratings:
1. 600V.
2. 90°C dry locations; 75°C wet locations.

D. Construction:
1. Conductor: Stranded soft annealed copper.
2. Insulation: Polyvinyl chloride with 5 mil nylon jacket.
3. Jacket: Polyvinyl chloride.

E. Conductor Identification:
1. #8 AWG and larger: ICEA Method 4.
2. #l0 AWG and smaller: ICEA Table K 2, Methods l and 4.
3. As shown on Drawings or Schedules.

2.04 ETHERNET CABLE

A. Labeled as c(UL)US compliant.

B. Verified to CAT6, Plenum Rated, 350 MHz, IEEE802.3/IEEE802.5.

C. Four pair, 23 AWG, Blue Jacket.

D. F/UTP Foil Shielded.

E. UL Temperature Rating: 75°C.

F. Flammability Test Rating: CMP.

G. Use ANSI/TIA/EIA compliant connectors and installation.

H. Belden 2413F or Engineer Approved Equivalent.

2.05 MODBUS CABLE

A. Two pair shielded cable.

B. 100% shield coverage.

C. Tinned copper conductors with tinned copper braided drain wire.

D. Belden 3107A, or equivalent.

2.06 FIBER OPTIC CABLE

A. Fiber optic cable shall be 6-strand, single mode, indoor/outdoor, non-unitized, Belden FDSD006R9 for riser cable and FDSD006P9 for plenum cable or Engineer reviewed equivalent.

2.07 OTHER WIRE AND CABLES

A. As supplied under other Sections or as required on the Drawings or Schedules.

PART 3 EXECUTION

3.01 COLOR CODING

A. 600V Power and General-Purpose Wire:
1. Neutral and ground as required by NEC. Where two neutrals are run in a conduit, make one white and one grey. For three: One white, one grey, and one white that is field marked with a band of grey tape at each end.
2. 480V Phases: Brown, orange, yellow (A, B, C, respectively).
3. 120/240V: Black and blue.
4. 120/208V: Black, blue, violet (A, B, C, respectively).
5. Motor Control Leads:
   a. THWN/THHN: Red to field devices with white (grey) neutral.
   b. Tray Cable: Inherent to cable.
6. THWN/THHN: #14 to #10 AWG: Colored insulation.
7. THWN/THHN: Larger than #0: Tape may be used.

B. TWSH and TC: Inherent to cable construction.

C. Color shall be the same from end to end of a run. Do not change conductor color at splices or terminal boards.

3.02 MARKING

A. Mark all field conductors unless directed otherwise on the Drawings or Schedules.

B. Text:
1. Power and Control Circuits associated with MCC:
a. Mark power feeders to motors with the motor control center number, cubicle number and terminal strip number, such as, 28 2A-T1 for MCC 28, cubicle 2A, phase A.
b. Mark control conductors with motor tag number followed by MCC cubicle terminal point number, such as, M394l-X2. Use pump or equipment number in the absence of a tag number.
2. All lighting circuits and power circuits not associated with a motor control center (MCC): Panel designation and circuit number, such as, LP1-12, or PPA-23, 25, 27.
3. Lighting and power circuits from a panelboard furnished as an integral part of an MCC: Panel designation and circuit number, such as, LP1-12, or PPA-23, 25, 27.
4. Control Circuits not associated with MCC: Terminal board number or wire number shown on schematics and/or submittals.
5. Instrumentation (all ends of complete run of all milliamp signal cables): Tag number, i.e., LS01, on pair, then "+" on positive conductor. Use black for positive polarity and white for negative.
6. Mark otherwise as specifically shown on the Drawings or Schedules.

C. Method:
1. Hot marked (embossed, not just surface printed) heat shrink tubing of the proper diameter, Raychem, or
2. Typed or computer printed, wrap-on, cloth adhesive labels held in place with a length of clear heat shrinkable tubing, or
3. Typed or computer printed, wrap-on labels held in place with a wrapped and heat bonded cover, 3M ScotchCode, or
4. Engineer reviewed equivalent.
5. Direct hot marking of wire or labeling methods, which depend solely on adhesive for attachment, are not acceptable.

D. Location: Install wire markers at every connection point to terminal boards, control stations, indicators, starters, instruments, and similar equipment, and at all splices.

3.03 TAGGING

A. Tag conductors and cables unless directed otherwise on the Drawings or Schedules.

B. Text:
1. Power and Control Circuits associated with MCC: MCC number and cubicle designation, such as MCC28-2BL.
2. All lighting circuits and power circuits not associated with a motor control center (MCC): Panel designation and circuit number, such as, LP1-12, or PPA-23, 25, 27.
3. Lighting and power circuits from a panelboard furnished as an integral part of an MCC: Panel designation and circuit number, such as, LP1-12, or PPA-23, 25, 27.

4. Control Circuits not associated with MCC: Name of equipment being controlled.
5. Instrumentation: Tag number.
6. Mark otherwise as specifically shown on the Drawings or Schedules.

C. Method:
1. Loosely group conductors of same service. Use tie wraps to keep grouped.
2. Install marking tag as specified in Section 26 05 53 – Electrical Identification.

D. Location: In pull boxes, handholes, manholes, and other enclosures where accessible but neither terminated nor spliced. It is not necessary to tag conductors in 4 x 4 or smaller boxes, or in conduit bodies.

E. Mark the cover of 4 x 4 or smaller boxes with a permanent black felt tip marker to indicate wiring content as required in Paragraph 3.03.B above.

3.04 INSTALLATION

A. Install all wiring in conduit, except where specifically allowed otherwise on the Drawings.

B. Bending Radii: Not less than permitted by ICEA or as recommended by cable manufacturer, whichever is greater.

C. Cable in cable trays, open wireway, and trenches:
1. Except for individual THWN grounding conductors, use TC or PLTC only.
2. Maintain separation between AC and DC cables.

D. Splicing:
1. Power Circuits:
a. Splicing of THWN/THHN conductors is permissible in boxes, enclosures, handholes, manholes or similar accessible and protected locations.
b. Splicing in conduit bodies is not permitted.
2. Control circuits and instrument wiring:
a. No splicing allowed.
b. If intermediate connections are required, provide enclosure and terminal block(s) where allowed by Engineer. Mark conductors as required above in this Section. Mark terminal boards as required in Section 26 27 27 – Wire Connectors and Accessories.
3. Direct buried splices allowed only as shown on the Drawings or Schedules.

E. Shields of TWSH:
1. Ground instrumentation cable shields at the PLC Cabinet.
2. Cut shield at field end 1/2″ shorter than cable pair(s). Install heat shrink tubing over shield to prevent contact with ground.

3.05 UNUSED CONDUCTORS

A. When a cable has conductors, which are not shown to be terminated then fold them back and tape in place. Do not cut short.

3.06 GROUNDING CONDUCTORS

A. Grounding Electrodes/Grounding Electrode Conductors: Bare copper.

B. Equipment Grounding Conductors: Insulated as required in Paragraph 2.01, or as part of a cable. Bare copper where shown on the Drawings.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

A. Furnish, install, connect, and test a complete grounding system for all non-current carrying conductive components and grounded circuit conductors of the wiring system, building structural steel, metallic piping, motor controls and panels, transformer neutrals and cases, motor frames, and other electrical systems and components.

B. Where grounding systems are not shown on the Drawings, as a minimum, ground in accordance with the National Electronic Code (NEC).

C. Where grounding systems are shown on the Drawings and are more stringent than required by the NEC, the Drawings take precedence.

1.02 SUBMITTALS

A. Literature for electrolytic ground rods.

PART 2 PRODUCTS

2.01 GROUND RODS

A. High carbon steel rod with minimum 0.01″ thick electroplated copper coating.

B. Minimum 5/8″ diameter and minimum 10′ long; provide larger if so scheduled or shown on the Drawings.

C. Nehring Electrical Works Company NCC series (NCCS series for sectional rods) or Engineer approved equivalent.

2.02 ELECTROLYTIC GROUND RODS

A. Manufacturer:
   1. Minimum 10 years' experience manufacturing electrolytic ground rods.
   2. International Organization for Standardization (ISO) 9002 certified.

B. Ground Rod:
   1. Underwriters Laboratories (UL) listed.
   2. 100% self-activating/sealed and maintenance-free without addition of chemical or water solutions.

3. Operate by hygroscopically extracting moisture from the air to activate the electrolytic process improving performance.
4. 100% Copper 2″ nominal diameter hollow copper tube with a minimum wall thickness of 0.083″.
5. Permanently capped on the top and bottom with air breather holes in the top of the tube and holes in the bottom of the tube for electrolyte drainage into the surrounding soil.
6. Factory filled with non-hazardous Calsolyte to enhance grounding performance.
7. 10′ long unless shown otherwise by Schedule or Drawings.
8. Provide a stranded 3/0 AWG Cu ground wire that is bonded to the side of rod by means of heavy-duty exothermic welding process unless called out otherwise on the drawings.
9. 25-year manufacturer's warranty.
10. Lyncole XIT or Engineer approved substitution.

C. Backfill Material:
1. Provide manufacturer recommended quantity but minimum 50 pounds per rod.
2. Natural volcanic, non-corrosive form of clay grout backfill material free of polymer sealants, which absorbs approximately 14 gallons of water per 50 pound bag for optimal 30% solids density and which has a pH value of 8-10 with maximum resistivity of 3 ohm-m at 30% solids density.
3. Lynconite II or Engineer approved substitution.

2.03 GROUND ACCESS BOX

A. Composite Box:
1. For non-traffic applications only.
2. Provide snap-lock flush cover with "breather" holes.
3. Nominal 12″ diameter by 10″ high.
4. Lyncole model XB-12F or Engineer approved substitution.
5. Use only where specifically called for on Drawings.

B. Precast Concrete Access Box, Medium Traffic:
1. Slots for conduit entrances.
2. Minimum size 10″ diameter by 12″ high.
3. Round cast iron grate flush cover with "breather" slots.
4. Lyncole Model XB-12C or Engineer approved substitution.
5. Unless shown otherwise on the Drawings, use in dirt areas, in sidewalks, and in asphalt dust aprons.

C. Precast Concrete Access Box, Heavy Traffic:
1. Minimum 12″ diameter by 10″ high.
2. Cast iron frame with lifting sockets.
3. Triangular cast iron cover with breather holes.
4. Lyncole model XB-22 or Engineer approved equal.
5. Unless shown otherwise on the Drawings, use in driveways, parking lots, access aprons, alleys (paved or otherwise), private streets, and public streets.

2.04 GROUND CONDUCTORS AND TAPS

A. Stranded soft-drawn bare copper.

B. Conductor Size: NEC Article 250, unless shown larger on Drawings.

2.05 CONNECTIONS

A. Use heavy duty exothermic welding process (HDEWP) or NEC/UL approved/listed compression connectors for all copper to copper grounding connections and for copper to ground rod connections.

B. Use NEC/UL approved/listed compression connectors from copper conductor to structural reinforcing rod. Burndy Hyground Hygrid YGL-C or Figure 6 Hytap YGHP-C, or equal.

C. Connection to power equipment (switchboard, MCC, panelboard, AFD, and similar): Install compression lugs on wire and bolt lugs to equipment ground bus.

PART 3 EXECUTION

3.01 CONDUIT AND RACEWAY SYSTEMS

A. Conduit Systems at Panels and Boxes: Double locknuts with sealing-type locknut on outside. Use bonding jumpers for conduits installed in concentric or eccentric knockouts and between conduits installed at non-metallic boxes.

B. Conduit Systems: Install a green insulated grounding conductor in all conduits for the length of the conduit. Size conductor in accordance with the NEC, as a minimum, unless otherwise specified on the Drawings. Use grounding bushing and connectors.

C. Install a #3/0 (minimum) bare copper grounding conductor under all underground primary power duct banks. No grounding conductor is required in primary conduits.

D. Install bare copper grounding conductors within or under other duct banks as shown on the Drawings.

3.02 SOLID GROUND RODS

A. Install in firm soil outside of excavated areas.

B. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.

C. Unless either excluded or shown otherwise on the Drawings, install access box at each rod. If box will have concrete cast adjacent to it, install 1/2″ expansion material around box before pouring concrete. Set box flush with concrete surface.

D. Depth:
   1. Where access box is installed, drive rod so top is 4″ below finished grade.
   2. Where access box is not installed, drive rod so top is 24″ below finished grade.

3.03 ELECTROLYTIC GROUND RODS

A. Install according to manufacturer's instructions.

B. Use for lightning protection grounds, whether specifically differentiated on the Drawings or not.

C. Use for other grounds where shown on the Drawings.

D. Install precast concrete access box at each rod. If box will have concrete cast adjacent to it, install 1/2″ expansion material around box before pouring concrete. Set box flush with concrete surface.

3.04 STRUCTURE GROUNDING ELECTRODE SYSTEM

A. Where shown on the Drawings, install bare copper grounding conductor in the concrete of the footing. Braze copper conductor to the tail of a reinforcing rod at minimum four places. Bond copper conductor to equipment where shown. Bond copper conductor to building structural steel columns, metallic piping, and similar, whether shown or not.

3.05 MARKING OF GROUND ACCESS BOXES

A. If called for on the Drawings, mark each ground access box.

B. Where an access box is surrounded by concrete, stamp the legend "GND" into the concrete adjacent to the box, minimum 1″ high letters.

C. Where an access box is surrounded by asphalt, pour a 20″ x 6″ x 12″ deep concrete marker in a nearby non-traffic area with the legend "GND BOX XX FT" where XX is the distance between the marker and the box and an arrow pointing to the box, minimum 1″ high characters.

D. Where an access box is surrounded by dirt, pour a 6″ x 6″ x 12″ concrete marker adjacent to it. Stamp the legend "GND" into the concrete, minimum 1″ high letters.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Strut Systems.

B. Supports.

C. Anchors.

1.02 SUBMITTALS

A. Information on materials and construction.

B. Provide diagrams to show how installed.

PART 2 PRODUCTS

2.01 CORROSION RESISTANT METAL STRUT SYSTEM

A. Channel:
1. Designed with edges turned in, forming lips which allow special spring loaded nuts to be inserted anywhere along the channel.
2. Material: 6063-T6 aluminum or 316L stainless steel.

B. Spring Loaded Nut and Spring:
1. Nut made of 316L stainless steel and designed to provide positive locking in place when tightened.
2. Spring made of zinc chromate plated steel or stainless steel.

C. Braces, brackets, and structural shapes used in the assembly of metal strut: 6063-T6 aluminum, 5052-H32 aluminum, or 316L stainless steel.

D. Threaded Rod, Bolts, and Nuts: 316L stainless steel.

E. All materials by the same manufacturer and designed as a system.

F. Dimensions and Style:
1. Single Strut: 1-5/8″ by 1-5/8″ – 12 gage, solid.
2. Back-to-Back Strut: 1-5/8″ x 3-1/4″ – 12 gage, solid.
3. As specifically noted otherwise on Drawings.

G. Unistrut, B-Line, Superstrut, or Engineer reviewed equivalent.

2.02 FIBERGLASS STRUT SYSTEM

A. Strut and Hanger Rod Construction: Linear glass strands, continuous mat laminates, and corrosion-resistant polyester resins simultaneously pultruded to form a uniform rigid thermoset shape.

B. Fiberglass: Self-extinguishing with Underwriters Laboratories (UL) 94 V-O classification.

C. Hanger Rod Washers: Stamped from pultruded flat stock.

D. Hanger Rod Square Nuts: Made from pultruded flat stock.

E. Hanger Rod Hex Nuts and Strut Nuts: Injection molded.

F. Hanger Rod Beam Clamps and Pipe Straps: Steel, with 15 mil polyvinyl chloride (PVC) coating and SS bolts.

G. Deflection Versus Loading and Recommended Loading: Equal to or better than that of Rob Roy Industries Rob-Glass Fiberglass Strut Support System.

H. Single Strut: 1.715 by 1.76 by 0.15 wall by length.

I. Back-to-Back Strut: 1.715 by 3.52 by 0.15 wall by length.

2.03 METAL STRUT SYSTEM

A. Same as Paragraph 2.01 except galvanized or painted steel.

B. Hardware: Zinc or cadmium plated.

2.04 ANCHORS

A. Comply with the requirements of Division 5, specifically with Section 05 50 01 – Anchor Bolts and Chemical Anchors. Lead shields with lag bolts: Not acceptable. Concrete Tapping Screws: Not acceptable.

B. Anchors Placed in Poured Concrete: Stainless steel expansion bolts, such as Hilti, Wejit, or equal, or chemical anchors.

C. Anchors Placed in Concrete Masonry Units:
   1. Chemical anchors.
   2. Toggle bolts may be used in hollow portions of concrete masonry units in Non-Process Indoor Areas.

PART 3 EXECUTION

3.01 ANCHORS

A. Comply with the installation requirements of Section 05 50 01 – Anchor Bolts and Chemical Anchors.

3.02 SUPPORT OF ALUMINUM CONDUIT AND BOXES

A. Support with stainless steel bolts, washers, and nuts and aluminum clamps, plates, angles, and/or strut.

3.03 SUPPORT OF OTHER CONDUIT AND BOXES

A. Support with stainless steel bolts, threaded rod, washers, and nuts and stainless steel clamps, plates, angles and/or stainless steel strut.

B. As allowed in Paragraph 3.05.

3.04 FLEXIBLE STRAP

A. Flexible steel and/or copper perforated straps (such as plumber’s tape) are not acceptable for support of any electrical item.

3.05 USAGE OF STRUT

A. Do not install fiberglass strut where exposed to sunlight.

B. Do not cast fiberglass or aluminum strut in concrete.

C. Follow manufacturer's recommendation as to maximum loading.

D. Do not exceed deflection stated in manufacturer’s literature.

E. Unless specifically allowed otherwise on Drawings, use painted Metal Strut Systems (Paragraph 2.03), only in Non-Process Indoor Areas.

F. Unless specifically allowed otherwise on Drawings, use galvanized Metal Strut Systems (Paragraph 2.03), only in Non-Process Indoor Areas, and in indoor spaces in which liquid sewage or sludge is not handled, such as a blower room.

END OF SECTION

SECTION 26 05 33.13

ELECTRICAL CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Conduit and accessories.

1.02 SUBMITTALS

A. Manufacturer's standard literature.

PART 2 PRODUCTS

2.01 RIGID METAL CONDUIT (RMC)

A. Steel RMC:
1. Meet National Electronic Code (NEC) 344 and American National Standards Institute (ANSI) C80.1.
2. Listed and labeled under Underwriters Laboratory (UL) 6 or Canadian Standards Association (CSA) recognized.
3. Electro-galvanized on outside, inside, and on threads.

B. Aluminum RMC:
1. Meet NEC 346, UL 6, and ANSI C80.5.
2. Listed and labeled under UL6 or CSA recognized.

2.02 POLYVINYL CHLORIDE COATED RIGID METAL CONDUIT (PVC RMC)

A. Standards:
1. Comply with NEC 344, UL 6, and ANSI C80.1.
2. Electronic Testing Laboratories (ETL) Verified to meet Intertek ETL SEMKO High Temperature Water polyvinyl chloride (PVC) Coating Adhesion Test Procedure, or successfully tested by UL for PVC adhesion after 240 hours at 100°C in an air-circulating oven and 600 hours of salt spray (fog) exposure in accordance with American Society for Testing and Materials (ASTM) B 117-94.
3. Each length of conduit shall bear the ETL Verification Mark "ETL Verified to PVC-001" and a UL6 label.

B. Steel Conduit: Threaded, then hot-dip galvanized inside, outside, and on the threads, then coated inside, outside, and on the threads.

C. External PVC Coating:
   1. 0.035″ to 0.045″ thick polyvinyl chloride on the full length of the exterior of the conduit except on the threads.
   2. Comply with NEMA RN 1 – Type A.
   3. Minimum strength of bond between galvanized steel and PVC coating: 3500 PSI.

D. External Urethane Coating:
   1. Minimum 2 mil thickness of clear two-part urethane.
   2. Apply on threads, overlapping the PVC coating and the inner coating.

E. Internal Urethane Coating:
   1. Minimum 2 mil thickness of colored two-part urethane.
   2. Finished Coating: Sufficiently flexible so it does not peel or crack when bends are made in the conduit.
   3. Apply on the full length of the interior of the conduit.

F. Boxes and Fittings:
   1. Listed and labeled under UL514B.
   2. Same materials as the conduit.
   3. Coated on the exterior, interior, and threads the same as the conduit.

G. Boxes, Fitting, and Sealing Fittings for Hazardous Locations:
   1. Listed under UL886.
   2. Same materials as the conduit.
   3. Coated on the exterior, interior, and threads the same as the conduit.
   4. Provide gas seals which are designed and manufactured so the total allowable fill in the gas seal is not less than the total allowable fill in the conduit.

H. PVC and Urethane Coating Repair Materials: By the conduit manufacturer.

I. Provide manufacturer's warranty that the conduit and fittings are free from defects in material and workmanship. Length of Warranty: 5 years from the date of shipment from the manufacturer's plant or 3 years from the date the installation is certified, whichever occurs last.

J. Perma-Cote, Robroy, Ocal, or Engineer reviewed equivalent.

2.03 RIGID NONMETALLIC CONDUIT (RNC)

A. Might be referred to as "RNMC" on the Drawings.

B. Meet NEC 352 and National Electrical Manufacturers Association (NEMA) TC2.

C. Listed/labeled under UL 651 for use with conductors operating at 90°C.

D. Ultraviolet (UV) resistant.

E. Schedule 40 PVC. Except Schedule 80:
1. Where called for in the Schedule.
2. Where installed exposed, or
3. Where called for on Drawings.

F. Glue all Joints Except:
1. Provide bell and spigot expansion joint with O-rings where required for expansion/contraction, and
2. Provide glue to thread fittings for transition to threaded conduit systems.

G. Fittings and Cement: By conduit manufacturer.

H. Carlon Plus 40 (Plus 80), or Engineer reviewed equivalent.

2.04 FIBERGLASS – REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Meet NEC 355 and NEMA TC14.

B. Listed/labeled under UL 2420 (below grade) and UL 2515 (above grade).

C. Manufacturing Process:
1. Manufactured using a single circuit filament winding process.
2. Winding mandrels shall be straight and true as to produce non-tapered conduits.
3. Epoxy based resin system with no fillers, using an anhydride curing agent.
4. Fiberglass shall consist of continuous E-glass Grade "A" roving.
5. Curing using two step oven heated process.
6. Interior conduit body walls shall be smooth and all fibers embedded in the epoxy.

D. Mechanical Characteristics:
1. Tensile Strength: 11,000 psi (ASTM D2105).
2. Compression Strength: 12,000 psi (ASTM D695).
3. Impact Resistance: ASTM D2444.

MINIMUM IMPACT RESISTANCE AT 0°C		
SIZE (INCHES)	**STANDARD WALL FT-LBS**	**HEAVY WALL FT-LBS**
0.75	20	150
1	25	400
1.5	35	500
2	40	550
2.5	55	600
3	70	700
3.5	80	850
4	120	1,000
5	160	1,200
6	200	1.300

E. Minimum Wall Thickness:

SIZE (INCHES)	STANDARD WALL – WALL THICKNESS (INCH)	HEAVY WALL – WALL THICKNESS (INCH)
0.75	.070	.25
1	.070	.25
1.5	.070	.25
2	.070	.25
2.5	.070	.25
3	.070	.25
3.5	.070	.25
4	.096	.25
5	.096	.25
6	.096	.25

F. Couple by means of bell and spigot with triple seal gasket or with glued couplers. Glued couplers required when there is no interference joint (e.g. after a field cut).

G. Elbows: Factory formed.

H. Factory assemble couplers onto conduit where adapting to different conduit types.

I. Two-Part Epoxy: Provided by manufacturer of conduit.

J. Champion Fiberglass or Engineer reviewed equivalent.

2.05 ELECTRICAL METALLIC TUBING (EMT)

A. Meet NEC 358. Listed/labeled under UL 797.

B. Connectors and Couplings:
1. Steel, not die-cast.
2. Rain-tight compression type, T&B TC11xA or equivalent.
3. Neither set screw nor indenter type will be acceptable.

2.06 FLEXIBLE METAL CONDUIT (FMC)

A. Meet NEC 348. Listed/labeled under UL 1.

B. Steel.

C. Use a single piece for each run. Do not use couplings.

D. Connectors: Steel squeeze type, Appleton Catalog Numbers 7480 through 7490, or Engineer reviewed equivalent.

2.07 LIQUID-TIGHT FLEXIBLE METALLIC CONDUIT (LFMC)

A. Meet NEC 350.

B. Listed/labeled under UL 360 for use in ambient temperatures from –30°C to +80°C, wet.

C. Galvanized steel with UV resistant PVC jacket.

D. Use a single piece for each run. Do not use couplings.

E. Connectors: Appleton ASTM series or Engineer reviewed equivalent.

2.08 LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Conform to NEC 356.

B. Listed/labeled under UL 1660 for use in ambient temperatures up to +80°C, dry; +60°C, wet.

C. Sunlight resistant.

D. Use a single piece for each run. Do not use couplers.

E. Connectors: Appleton ASTM series or Engineer reviewed equivalent.

2.09 OTHER CONDUITS

A. Meet requirements of appropriate NEC article and applicable UL standard.

B. Use only after specific written approval of the Engineer.

2.10 FLEXIBLE EXPLOSION-PROOF COUPLING (XPFC)

A. Listed/labeled under UL 886.

B. Braided steel or copper alloy with inner insulating sleeve.

C. Fittings: Threaded.

D. Crouse-Hinds Series EC, or Engineer reviewed equivalent.

2.11 CONDUIT GAS SEALS

A. Approved for use in Class I and Class II areas as defined in NEC Article 500.

B. Listed/labeled under UL 886.

C. Malleable iron construction with NPT threads.

D. Where used with PVC RMC or RTRC conduit, provide seals with the same coating systems as the conduit and other fittings.

E. Designed so the cross-sectional area is larger than or equal to the cross-sectional area of the conduit.

F. Where installed through enclosure wall, also use sealing ring with SS retainer, T&B 5262 series.

PART 3 EXECUTION

3.01 CONDUITS REQUIRED

A. Many conduits and associated conductors are not shown or are only partially shown on plan views in the Drawings. Install as if fully shown.

B. In addition to conduits that are shown on plan views in the Drawings:
1. Install conduits as shown in any conduit Schedules. If Schedules are used, they are appended to this Specification or are included on the Drawings.
2. An entry in a conduit Schedule requires conduits and conductors end-to-end, complete. For example, there is only one entry for a given motor feeder, even though there is actually one conduit and set of conductors shown from the starter to the local disconnect switch and another from the disconnect switch to the motor.
3. Install as implied for circuiting, such as where a panelboard circuit number is shown adjacent to a wiring device, and from switches to associated luminaires.
4. Install as called for in Panelboard Schedules.
5. Install as called for in tables shown as part of schematic diagrams.
6. Install as required for control of process equipment. Pay special attention where recommendations of the manufacturer of the process equipment supplied differ from that shown in the design.
7. Install as required for a complete system.
8. Install as called for on the One-Line Diagram.

3.02 INSTALLATION

A. Conduit Bends:
1. Factory made or made with a conduit bending machine recommended by the conduit manufacturer.
2. If EMT is specifically allowed in the matrix of conduit usage then bends in EMT may be made with a hand bender which fully supports the side walls.

B. Wrench tighten all threaded joints, couplings, fittings, and connectors.

C. Run conduits concealed in finished areas and where indicated on the Drawings. In many places, such as at motors and surface-mounted wiring devices in pump rooms and electrical rooms, the end of a run may be an exposed vertical riser even though the symbol used for the conduit denotes concealed.

D. Run exposed conduit either parallel with or perpendicular to structural members of the building or structure except where allowed otherwise by the Engineer.

E. The only conduit that may be above a roof is conduit that serves equipment on that roof. Locate roof penetrations so no horizontal runs of conduit are required on the roof.

F. Conduit installed above lay-in ceilings will be considered to be concealed, and need not comply with parallel/perpendicular requirements for exposed conduit. Route to avoid interference with piping, duct work, and luminaries. Locate conduit well above the lay-in ceiling. Support independently of ceiling suspension wires.

G. Do not install conduit on slabs, decks, sidewalks or floors where it may create a trip hazard. The Engineer or Owner judges what conditions are "trip hazards." Conduits may be installed on slabs only with written permission from the Engineer or Owner.

H. Drainage: Avoid pockets in conduit runs. Provide suitable drainage fittings in low spots in exposed conduit. Weep holes not permitted.

I. Field Cuts and Threads:
1. Cut ends of conduit square. Ream to remove burrs and sharp edges.
2. Non-Factory Threads: Same effective length, thread dimensions, and taper as factory cut threads.
3. Carefully remove burrs from threads.
4. For steel RMC, paint conduit threads with vinyl repair compound, same as used for PVC RMC.

J. Supports:
1. Comply with NEC and Section 26 05 29 – Hangers and Supports.
2. In horizontal conduits runs install one-hole conduit straps with the anchor below the conduit.

K. Conduit Ends:
1. Where conduits terminate in hand holes, manholes, trenches, floor cavities, or similar, or through concrete into open-bottom enclosures plug spaces between conductors/cables and conduit with duct seal.
2. Protect conduit ends during construction to prevent entrance of foreign material.
3. Install insulated throat grounding bushing on conduit ends and install bonds as specified in Section 26 05 26 – Grounding and Bonding, and as required by the NEC.
4. Where conduits enter an enclosure from underground, whether through concrete or from earth (such as in a transformer), set end of conduit at 2-3″ above the surrounding or nearby concrete.

L. Clean and swab inside by mechanical means to remove foreign materials and moisture before wires or cables are installed, also for spare conduits.

M. Spare Conduits:
   1. Blow a pull string through the conduit.
   2. If end is buried or exposed to weather, glue pull string to inside of cap with silicone seal, let set, leave adequate slack, then install cap.
   3. Where not exposed to weather, seal conduit end with duct seal.

N. Use anti-seize compound on threads of aluminum RMC.

O. Conduit and Boxes Installed on Guard Rails:
   1. Allowed only where shown on the Drawings or where specifically proposed in writing by the Contractor and approved by the Engineer.
   2. If allowed for conduits, mount on the outside of the rail (opposite from the walking surface).
   3. If allowed for enclosures, install strut on the outside of the rail then extend upward to support enclosures.
   4. Where guard rail is removable, provided with a gap and chains, or has a gate, run conduit on the side of the bridge, below the level of the walking surface.

P. Where shown on Drawings, provide sleeves for conduit penetrations. Where the penetration is through the wall of a process structure which contains water, provide mechanical "link-seals" between the inside of the sleeve and the outside of the conduit. Seal other penetrations with 40-year rated silicone seal.

Q. Requirements where conduits enter/exit a structure or building below grade:
   1. Do not run conduits in or through footings.
   2. Bury conduits larger than 2″ trade size minimum 12″ below the bottom of the footing.
   3. Fewer than five conduits of 2″ trade size or less in a loose grouping may penetrate the stem wall.
   4. More than five conduits of any size in a grouping:
      a. Bury minimum 12″ below the bottom of the footing, or
      b. Submit structural details of block-outs and reinforcing through the stem wall for review by the Engineer. After conduits are installed through a block-out, fill the remaining space with non-exothermic, non-shrink grout.

R. Expansion Joints: Where conduit spans building expansion joints or in long duct runs, use expansion fittings and bonding jumpers.

3.03 INSTALLATION OF PVC RMC

A. Comply with installation requirements of Paragraph 3.02. In addition, comply with the requirements of Paragraph 3.03.

B. Obtain training and certification of installers of PVC RMC from the manufacturer and use only installers who are trained and certified and whose records are on file with the Engineer, all specifically for this project.

C. Use special bending tools, vise jaws, pliers, wrenches, drivers, and other tools designed for working with PVC RMC to eliminate damage to the PVC coating.

D. Repair external coating where damaged. Apply coating repair liquid in multiple coats so the thickness of the coating at the entire damaged area is minimum 80 mils.

E. Paint all metal surfaces exposed by field cutting and/or threading with colored two-part urethane and allow to dry before installing conduit.

F. Paint male threads with coating repair liquid immediately prior to installation of a fitting or coupling.

G. During installation, seal PVC to PVC at the joints with coating repair liquid.

H. The requirements of the above five paragraphs are minimum requirements, even if more stringent than the recommendations of the manufacturer. If portions of the recommendations of the manufacturer are more stringent than the above, follow those as well. Bring objections of the conduit manufacturer (if any) to the Engineer for resolution.

I. Furnish the services of an authorized representative of the conduit manufacturer to inspect the finished installation.
   1. If the representative cites installation problems, then rectify the problems.
   2. When the representative finds the installation to be at least in accordance with the manufacturer's recommendation, then obtain from the representative and furnish to the Owner a certification from the conduit manufacturer that the installation conforms to the manufacturer's recommendations and that the Manufacturer's Warranty is in effect.
   3. If during the warranty period any material or the installation of any material is defective, replace or repair such material as mutually agreed between the Owner and the Contractor. Replacement or repair operations shall not adversely affect the warranty.

3.04 INSTALLATION OF RTRC

A. Comply with installation requirements of Paragraph 3.02.

B. Obtain training and certification of installers of RTRC from the manufacturer and use only installers who are trained and certified and whose records are on file with the Engineer, all specifically for this project.

C. Use special tools designed for working with RTRC.

D. Where installed below grade or embedded in concrete, use only Heavy Wall RTRC for sweeps, 90's, and transitions in and out of concrete.

E. Where installed in a Class I Division 2 location, for below grade elbow elbows, and where penetrating a concrete slab, only Heavy Wall RTRC shall be used. All other locations Standard Wall is acceptable, except if noted otherwise in the Schedule or on the Drawings.

F. Where installed in Class 1 Division 2 locations, if in the Schedule, or were required on the Drawings, furnish the services of an authorized representative of the conduit manufacturer to inspect the finished installation.
   1. If the representative cites installation problems then rectify the problems.
   2. When the representative finds the installation to be at least in accordance with the manufacturer's recommendation, then obtain from the representative and furnish to the Owner a certification from the conduit manufacturer that the installation conforms to the manufacturer's recommendations.
   3. If during the warranty period any material or the installation of any material is defective, replace or repair such material as mutually agreed between the Owner and the Contractor. Replacement or repair operations shall not adversely affect the warranty.

3.05 DUCT BANKS

A. Where duct bank is shown on the Drawings, encase conduits in 4000 PSI concrete. Comply with the requirements of Division 2 for earthwork and of Division 3 for concrete.

B. Drawings show known interferences, but others may exist. Where close to known interferences or where evidence of other interferences is found in the field, hand excavate trench.

C. Install conduits using plastic spacers. Provide spacers maximum of 8′ on center, but closer where so shown in the conduit manufacturer's instructions or where required for adequate support at elbows, offsets, or sweeps.

D. Remove mud and other foreign substances from conduits before pouring of concrete.

E. Provide minimum 3″ of concrete all around the outside of conduits. Provide minimum 3″ of concrete between walls of adjacent conduits.

F. To prevent floating, tie down duct banks with reinforcing bars and steel wire before pouring concrete.

G. Dye all concrete red. Use 7-8 pounds of Bayferrox CC16 Red dye, or Engineer reviewed equivalent, per cubic yard of concrete mix.

H. Prevent loose dirt from falling into trench during concrete pouring operations.

I. Pour each section, i.e. riser to riser, riser to pull box, pull box to pull box, etc., of duct in one operation. If such construction is not feasible, construction joints will be permitted, subject to review of Engineer, provided 40 mil PVC RMC is used a minimum of 5′ on both sides of joint, and at minimum four #4 by 10′ reinforcing bars are run through the joint.

J. Make sure that concrete flows all around all conduits by suitable means, except do not use mechanical concrete vibrators and do not significantly displace conduits.

K. Duct bank concrete may be poured without forming, provided trench walls are firm and do not cave; otherwise, use forms as specified in Division 3.

L. After construction of duct banks is complete, pull a mandrel through each duct. Use a mandrel 1/4″ smaller in diameter than duct unless the manufacturer recommends otherwise. If any obstructions are encountered or if there is evidence of water pocket in duct, locate, remove, and replace that section at no cost to Owner.

M. Where shown on the Drawings, install bare copper ground wire under or in concrete of duct bank. Connect to ground conductors/ground bars at each end.

3.06 APPLICATION

A. RMC:
1. Steel RMC is not permitted direct buried.
2. Aluminum RMC is Not Permitted:
    a. In contact with earth.
    b. Embedded in concrete.
    c. In contact with concrete below grade, outdoors, or in wet indoor locations.

B. PVC RMC:
1. Permitted in areas subject to corrosive environment.
2. Permitted underground, direct buried.
3. Use where required by other Paragraphs of this Section or other Sections.
4. Permitted for elbows in larger size underground installations of RNC.
5. Use for all penetrations of slabs except:
    a. Where a run of RNC comes into the bottom of an enclosure having an open bottom, such as a motor control center (MCC).
    b. Where the upward continuation of a run is anchored to a block or poured concrete wall directly and close above the penetration.
    c. Where the upward continuation of a run will be hidden within a wall.
    d. Where Heavy Wall RTRC is used to penetrate a slab.

C. RNC:
1. Do not use where exposed to direct sunlight.
2. Permitted underground or direct buried.
3. Do not use RNC elbows for underground installations with conduit sizes 2″ or greater. Elbows may be RTRC or PVC RMC.

D. RTRC:
   1. Permitted in areas subject to corrosive environment.
   2. Permitted underground, direct buried.
   3. Permitted for elbows in larger size underground installations of RNC.
   4. Use where required by other paragraphs of this Section or other Sections.

E. EMT:
   1. Use only where shown in the matrix of conduit usage.

F. Flexible Conduits:
   1. Use for final connection to luminaires, motors, dry type transformers, heating, ventilation, and air conditioning (HVAC) equipment, water heaters, unit heaters, and similar applications.
   2. Do not install within a wall or slab. Do not install as/in a penetration of a wall or slab.
   3. Do not install in lengths of more than 18″ except:
      a. For connection of lay-in luminaries.
      b. For connection of equipment where Operation and Maintenance (O&M) Manual recommends moving it for maintenance, such as certain models of uninterruptible power supply systems.
      c. For connection of adjustable frequency drives.
      d. Where proposed in writing case-by-case by the Contractor and specifically allowed by the Engineer. No other exceptions to length restrictions.
   4. LFMC and LFNC: Allowed as a factory component of luminaires and/or process equipment.
   5. FMC: Allowed as a factory component of luminaries.
   6. Use FMC for connections to adjustable equipment and devices in air ducts or plenums.

G. Use XPFC for final connection to motors or other equipment subject to vibration in Class I Division 1 areas; also in Class I Division 2 areas if so required by NEC. XPFC is not shown in the matrix of conduit usage but use as required by above, by NEC, and where specifically called for on the Drawings.

H. All Conduits:
   1. Use type specifically called for on the matrix of conduit usage. If not shown in the matrix of conduit usage, comply with requirements shown on the Drawings. If not shown in either the matrix of conduit usage or on the Drawings, refer to the matrix of conduit usage for all other work.
   2. No plastic conduit allowed above lay-in ceilings where the cavity functions as an air-handling plenum, regardless of matrix of conduit usage.
   3. Do not install exposed conduits in finished areas, such as laboratories, offices, training rooms, and similar. Clarify any questionable area with the Engineer in the field before installing.

I. Matrix of Conduit Usage:

1. A matrix of conduit usage may be shown on the Drawings.
2. If multiple columns are marked, any marked type is allowed subject to NEC restrictions and restrictions above, such as but not limited to those concerning buried conduits, elbows, penetrations, exposed installation, and use in cavities.
3. Different parts of a run may be of different type conduit, such as where a flexible connection is required.
4. If a column is marked "C" then use only where concealed in a wall or above a gypsum board or lay-in ceiling.
5. If a column is marked "CA" then use only above a gypsum board or lay-in ceiling.
6. If a column is marked "E" then use only for connections between electrical supply and control equipment, not for connection of utilization equipment and not for connection of field devices such as flow transmitters and hand switches. A marking of "E" is typically intended to be limited to electrical rooms.
7. If a column is marked "H" then use only above 6′ or directly above equipment where not subject to damage.
8. See matrix of conduit usage for other column marking notes.
9. Where the matrix of conduit usage shows RNC for outdoor use, it is allowed only where protected from direct sun exposure, such as under a bridge or under a digester cover.

3.07 SIZE

A. The Drawings and/or Conduit Schedules may show a minimum size for certain conduit runs. Where size is not shown, then comply with Paragraph C below.

B. If a conduit size has to be increased because a motor or other equipment furnished by the Contractor requires more power (and therefore larger wire and conduit than shown) than the specified motor or equipment, then include the cost of the larger conduit in the Bid.

C. Minimum Size Requirements: As required by NEC, but no smaller than 3/4″ unless otherwise shown on the Drawings.

END OF SECTION

SECTION 26 05 33.16

BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Boxes.

1.02 REFERENCES

A. See Specification 26 27 16 – Cabinets and Enclosures.

1.03 SUBMITTALS

A. Manufacturer's Literature.

PART 2 PRODUCTS

2.01 BOXES LOCATED OUTDOORS AND IN PROCESS AREAS

A. National Electrical Manufacturers Association (NEMA) 4X, epoxy painted or 316L stainless steel.

B. Heavy-Duty Device Boxes for use with Rigid Metal Conduit (RMC):
1. Copper-free cast aluminum.
2. Conduit hubs cast integral with box.
3. Hubs exterior to box.
4. Conduit hubs with tapered threads (NPT).
5. Integral green ground screw.
6. Unless explicitly shown otherwise on Drawings, covers by same manufacturer as box.
7. Crouse-Hinds FS/FD series or equivalent.

C. Heavy Duty Device Boxes for use with polyvinyl (PVC) RMC: Same as Paragraph B but from the manufacturer of PVC RMC and coated the same as the conduit.

D. Standard Duty Device Boxes for use with RMC:
1. Die-cast aluminum.
2. Conduit hubs cast integral with box.
3. Hubs interior to box.
4. Conduit hubs with tapered threads (NPT).
5. Red Dot or Engineer approved equivalent.

E. As called out in specific Sections or on the Drawings.

2.02 BOXES LOCATED IN NON-PROCESS INDOOR AREAS

A. NEMA 12 for starter enclosures, control panels, and similar unless a different type is called for on the Drawings or in specific Sections or as scheduled.

B. Device Boxes for use with EMT:
1. Single piece steel with conduit knockouts.
2. $4''^2$ x 2-1/8″ deep, with appropriate device cover.
3. Steel City Catalog No. 2G4D series or Engineer approved equivalent.

C. Device boxes for use with rigid conduit: Paragraph 2.01 D.

D. As called out in specific Sections or on the Drawings.

2.03 BOXES LOCATED IN HAZARDOUS AREAS

A. Copper-free cast aluminum.

B. Underwriters Laboratories (UL) listed for National Electrical Code (NEC) Class and Division where installed.

2.04 CONDUIT CONNECTORS

A. NEMA 4X Boxes: Watertight hubs; PVC coated watertight hubs for use with PVC RMC.

B. Cast Boxes: Threaded portion of box.

C. NEMA 12 Boxes: "O-ring" type lock nut connectors.

D. NEMA 3R Boxes: Lock nut connectors for conduit connections to the bottom of the box but watertight hubs for all other conduit connections.

E. Steel boxes used with EMT:
1. Steel, not die-cast.
2. Concrete-tight and rain-tight.
3. Compression type, not set screw nor indenter type.
4. Steel City TC-11x series, or Engineer approved equivalent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Boxes: Securely support independent of conduits so that they are level and in vertical and horizontal alignment.

B. Flush Boxes: Properly plumb, flush, and aligned with the surface surrounding it.

C. Boxes Outside:
   1. Fully accessible and visible.
   2. Do not use “Exception” to Article 314.29 of the NEC.

D. Device Boxes:
   1. Unless shown differently on Drawings or required by field conditions, inside in non-process areas mount receptacle boxes 18″ centerline above finished floor.
   2. Unless shown differently on Drawings or required by field conditions, outside and in process areas mount receptacle boxes 30″ centerline above finished grade or floor.
   3. Unless shown differently on Drawings or required by field conditions, mount toggle switch boxes 48″ centerline above finished floor.
   4. Install heavy duty device boxes unless the use of standard duty device boxes is explicitly called for on Drawings.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates and marking tags.

1.02 SUBMITTALS

A. Not required.

PART 2 PRODUCTS

2.01 NAMEPLATES (NP)

A. Minimum Character Height:
1. 1/2” for the title of equipment which meets any of the following criteria:
   a. Oil-filled transformers
   b. Engine generator sets
   c. Motor Control Centers (MCC)
   d. Floor mounted PLC enclosures
   e. Automatic and manual transfer switches
   f. Service disconnecting means
   g. Equipment 400 Amps or greater
   h. Equipment greater than 600 Volts
   i. Equipment with interrupt rating greater than 22kAIC
2. 3/8” for the title of equipment which do not meet the criteria above and meets any of the following criteria:
   a. Dry transformers
   b. Individual starters
   c. Individual MCC sections
   d. Panelboards rated less than 400 Amps
   e. Motor/equipment disconnecting means
   f. Motor and/or control terminal boxes
   g. Wall mounted control panels
3. 1/8” minimum for other text but larger as specified below or if called for on the Drawings.

B. Engraved Nameplates:
1. Black engraving stock with white core, unless shown otherwise, below or on the Drawings.
2. Gravoply, or Engineer reviewed equivalent.

C. Printed Nameplates:
   1. Vinyl, self-adhesive tape. Provide white, tan (sand) or gray for least contrast with color of surrounding surface.
   2. Color of lettering: Black.
   3. Brady™ Handimark® Printer with Brady B-580 tape or Engineer reviewed equivalent.

2.02 CAUTION AND WARNING NAMEPLATES

A. Comply with NEC and OSHA requirements.

B. Engraved Nameplate: Red with white text.

C. Instead of an engraved or custom-printed label, a standard, off-the-shelf label, such as from Seton, is acceptable.

D. Character Size: 1/4" minimum height.

2.03 MARKING TAGS

A. Engraved plate as in Paragraph 2.01 with minimum 1/8" character height.

B. Drill hole for attaching.

C. Attach with tie wrap.

PART 3 EXECUTION

3.01 NAMEPLATES REQUIRED

A. Motor Nameplates:
   1. Install a red nameplate on each motor or other electrically controlled equipment that has maintained (two-wire), remote, or automatic control.
   2. Character size: Caution: 1/2" characters; balance: 1/4".
   3. Text equivalent to "CAUTION. THIS EQUIPMENT MAY START AUTOMATICALLY OR REMOTELY."
   4. Instead of an engraved or custom-printed label, a standard, off-the-shelf label, such as from Seton, is acceptable. Comply with NEC and OSHA requirements.

B. Voltage Warnings: As required by NEC and OSHA.

C. Where called for in other Sections.

D. As scheduled.

E. As required on the Drawings. Generally, a note on a Drawing will call for a nameplate or NP. The type (engraved or printed) is mentioned on the Drawings only if an engraved NP is required in a location in which a printed NP might otherwise be allowed in the Paragraphs below.

3.02 MOUNTING OF NAMEPLATES

A. Engraved Nameplates:
   1. Use indoors or outdoors.
   2. On panel fronts, attach with screws or drive rivets. Elsewhere, attach with 30 year rated silicone seal.
   3. Attach with edge parallel to edge of enclosure or device plate.

B. Printed Nameplates:
   1. Use only inside a fully enclosed and roofed building or structure.
   2. Do not use where exposed to sunlight, precipitation, freezing temperatures.
   3. Do not use where Drawings call for engraved NP.
   4. Self-adhesive.
   5. Attach with edge parallel to edge of enclosure or device plate.

3.03 SCHEDULE

A. Minimum nameplate requirements. Refer to Drawings and other sections for additional requirements. Where italicized enter equipment specific information and where bold text is fixed.
   1. Panelboards, switchgear, MCCs and similar:
      a. Line 1: Equipment Name.
      b. Line 2: Fed From: Source equipment.
   2. Transformers:
      a. Line 1: Equipment Name.
      b. Line 2: Fed From: Source Equipment.
      c. Line 3: Feeding: Destination Equipment.
   3. Automatic and Manual Transfer Switches:
      a. Nameplate 1:
         Line 1: Equipment Name.
         Line 2: Feeding: Destination Equipment.
      b. Nameplate 2 (install next to respective position/indication):
         Line 1: Source 1: Source Equipment.
      c. Nameplate 3 (install next to respective position/indication):
         Line 1: Source 2: Source Equipment.
   4. Equipment disconnecting means located near the respective equipment, starter and equipment controllers not located in a MCC and similar:
      a. Line 1: Equipment Name.
      b. Line 2: Equipment Tag Number.
      c. Line 3: Fed From: Source equipment.
   5. MCC Cubicles (Starters):
      a. Line 1: Equipment Name.
      b. Line 2: Equipment Tag Number.
      c. Line 3: Starter Type and Size (e.g. VFD, FVNR Size 2, RVSS).
      d. Line 4: Load HP rating.

6. MCC Cubicles (Circuit Breaker):
    a. Line 1: Circuit breaker rating.
    b. Line 2: Feeding Equipment Name.
7. MCC Cubicles (Feeders):
    a. Line 1: Feeder Circuit Breaker or Feeder Lugs.
    b. Line 2: Fed From: Source equipment.
8. MCC Cubicles (Miscellaneous):
    a. Line 1: Description of cubical (e.g. Spare FVNR Size 1, E-Net I/O).
    b. Line 2: Tag number if applicable.

END OF SECTION

SECTION 26 08 10

ELECTRICAL TESTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical testing.

1.02 SUBMITTALS

A. Four copies of megger test reports.

B. Four copies of performance test reports.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide equipment to perform testing.

B. Test equipment shall bear a current calibration sticker which shows performance, when it was calibrated, and when it is next due for calibration.

C. Have calibration performed by a testing laboratory which uses reference instruments whose accuracy is documented and traceable to National Institute for Standards and Technology reference standards.

PART 3 EXECUTION

3.01 MEGGER TESTING

A. Test feeder and branch circuits which will operate at greater than 250V to ground with a 1000V megohm meter.

B. Record test results between phases, phase to neutral, phase to ground, and neutral to ground.

C. Prepare and submit test reports.

D. Tests deemed unsatisfactory by the Engineer:
   1. Replace defective conductor and all other conductors which are in the same conduit.
   2. Re-test and re-submit.

3.02 PERFORMANCE TEST

A. Demonstrate to the Engineer the satisfactory performance of all electrical equipment moved, modified, or provided under this Contract including, but not limited to, demonstrating that all equipment works properly in HAND and that hardware type automatic control components and systems work properly.

B. Calibrate plant equipment and instrumentation as required for proper operation.

C. If testing and/or calibration requirements are shown in Division 40:
   1. Perform megger testing as required in this Section.
   2. Where more stringent performance testing or more stringent calibration procedures are required in Division 40, follow those more stringent requirements and submit reports as required in Division 40.

3.03 OTHER TESTS

A. As required in other Sections.

3.04 WITNESS

A. Notify Engineer minimum 3 working days before megger testing.

B. Notify Engineer minimum 7 working days before performance testing.

C. Engineer will either witness the testing or waive the requirement.

END OF SECTION

SECTION 26 22 13.10

LOW-VOLTAGE DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Low voltage transformers dry type transformers for general lighting and power service.

1.02 SUBMITTALS

A. Complete manufacturer's catalog cuts with ratings.

PART 2 PRODUCTS

2.01 DRY TYPE TRANSFORMERS

A. UL Listed/Labeled two-winding dry type transformers with voltage, phases, and kVA ratings as shown on Drawings or Schedule.

B. Copper windings.

C. Connection: Furnish three phase transformers with delta connection on higher voltage windings and wye connection on lower voltage windings.

D. Maximum design temperature rise over 40°C ambient:
   1. Single phase:
      a. 2 kVA and less - 80°C.
      b. 3 kVA through 25 kVA - 115°C.
      c. Greater than 25 kVA - 150°C.
   2. Three phase:
      a. 45 kVA and less - 115°C.
      b. Greater than 45 kVA - 150°C.

E. Furnish transformers rated 30 kVA and less with core and coil resin encapsulated suitable for indoor or outdoor use.

F. Furnish transformers rated greater than 30 kVA with ventilated enclosure rated NEMA 1 where installed indoors or NEMA 3R where outdoors.

G. Minimum taps required:
   1. Transformers rated 3 kVA or less: No taps.
   2. Transformers rated greater than 3 kVA through 30 kVA: Two 2 ½ % full capacity above normal (FCAN) and two 2 ½ % full capacity below normal (FCBN) taps.

3. Transformers rated greater than 30 kVA: Two 2 ½ % full capacity above normal (FCAN) and four 2 ½ % full capacity below normal (FCBN) taps.

H. Furnish transformers with different or other features as shown on Drawings or Schedule, such as but not limited to aluminum windings, different winding connections, additional taps.

I. Transformers which fall within the scope of the Guide for Determining Energy Efficiency for Distribution Transformers, published by the National Electrical Manufacturers Association® (NEMA® TP-1-2002): Meet Class I Efficiency Levels for distribution transformers specified in Table 4-2 of the Guide.

J. Cutler-Hammer type EP and DS-3 single phase or type EPT and DT-3 three phase, General Electric type QB, QMS, and QL single phase and type QMS3 and QL three phase, Square D Class 7400, or Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install transformer plumb and level.

B. Provide clearance around transformer for access and ventilation as recommended by manufacturer.

C. Use flexible conduit for connections to transformer case. Make conduit connections to transformer enclosure only at locations designated by the manufacturer's installation instructions.

D. After normal operating load have been energized, measure secondary voltages and adjust tap settings as necessary. Record tap settings on record drawings.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Panelboards.

1.02 SUBMITTALS

A. Summary Sheet showing:
1. Voltage, phases, and main bus ampacity.
2. MLO panels: Type of main lugs.
3. MCB panels: Main breaker rating.
4. Neutral and ground bar ratings.
5. Bus material and plating.
6. Short circuit rating.
7. Flush or surface mount, enclosure NEMA type, and trim details.
8. Rating and arrangement of branch circuit breakers.
9. Description of specified factory assembled modification including, but not limited to, sub-feed breakers, sub-feed lugs, feed-through lugs, and metering transformers.

B. Panelboard layout showing all circuit breakers, strapping and mounting hardware for future circuit breakers, and space for future strapping and mounting hardware.

C. If the submitted circuit breaker layout differs from the Drawings then demonstrate that the phase current balance will be substantially the same.

1.03 OPERATIONS AND MAINTENANCE DATA

A. As-built layout drawing showing location, ampacity, and poles of each breaker.

B. Copies of all directories.

C. Settings used for electronic trip units and ground fault relays.

1.04 QUALITY ASSURANCE

A. Conform to the following:
1. UL 50 Enclosures for Electrical Equipment.
2. UL 67 Panelboards.
3. NFPA 70 National Electrical Code.
4. NEMA PB1 Panelboards.
5. UL 489, “Molded Case Circuit Breakers and Circuit Breaker Enclosures.”

6. NEMA AB1, “Molded Case Circuit Breakers.”

PART 2 PRODUCTS

2.01 PANELBOARDS – COMMON REQUIREMENTS

A. Voltage, phases, and current ratings as shown on Drawings.

B. Minimum branch circuit breaker space as shown on Drawings.

C. Minimum Box Width:
1. 14 inches for:
   a. 100 Amp, single phase, flush mounted.
   b. 100 Amp, 208Y/120 volt, three phase, flush mounted.
2. 20 inches for all others.

D. Main circuit breaker (MCB) or main lugs only (MLO) as shown on Drawings.

E. Bus: Tin plated aluminum unless shown otherwise on the Drawings or Schedule.

F. Ground Bar: Furnish all panelboards with a ground bar having a screw for each pole.

G. Neutral Bar:
1. 208Y/120 Volt and 120/240 Volt single phase panelboards: Provide 100 percent neutral bar with a screw for each pole unless shown otherwise on the Drawings or Schedules.
2. 480Y/277 Volt panelboards which are used as service equipment: Provide 100 percent neutral bar.
3. 480Y/277 Volt panelboards which power 277 Volt loads, such as site lighting and UV systems, and elsewhere required on the Drawings: Provide 100 percent neutral bar with a screw for each pole.
4. 480 Volt panelboards which power no 277 Volt loads: No neutral bar required.

H. Furnish sub-feed breakers, sub-feed lugs, feed-through lugs or other factory options as shown on Drawings.

I. Flush or surface mount as shown on Drawings.

J. Listed and labeled for service entrance use if used for service entrance equipment or so indicated on Drawings.

K. Circuit Breakers:
1. Furnish circuit breakers recommended by the manufacturer of the panelboard for use in the panelboard furnished.
2. Provide as shown on Drawings or Schedules.

L. Furnish all required strapping and mounting hardware required for the future installation of a circuit breaker of the frame size shown where “FUTURE” is shown on the Drawings or Schedules.

M. Furnish a panelboard with the required space for the future installation of strapping, mounting hardware, and circuit breakers where “SPACE” is shown on the Drawings or Schedules.

N. Circuit Breaker Mounting and Connection:
1. Connection between line side of circuit breaker and bus by direct bolted connection, or
2. Connection between line side of circuit breaker and bus by spring tension jaws designed to produce increased contact pressure under fault conditions and entire circuit breaker secured in place with bolt, and
3. No restriction on ability to mount circuit breakers of different frame size or number of poles opposite each other.

O. Manufacturers and Types:
1. Cutler-Hammer: Pow-R-Line 1 and Pow-R-Line 2.
2. General Electric: AQ, AE, and AD.
3. Square D: NQOD and NF.
4. Engineer reviewed equivalent.

2.02 ENCLOSURE AND TRIM

A. Enclosure rated NEMA 1, NEMA 3R, NEMA 4, NEMA4X SS or NEMA 12 as shown on Drawings or Schedules.

B. Enclosure constructed of zinc-coated sheet steel for all but NEMA4X SS.

C. For NEMA 3R, 4, and 12, provide enclosure with exterior surfaces prepared, primed and painted in a light grey, ANSI 49 or similar color, at the factory.

D. Flush mounted 208Y/120 Volt and 120/240 Volt single phase panelboards rated 100A: Furnish with decorative trim fastened to the box on four sides with screws or screwdriver operable captive latches and a hinged and latched door to cover access to circuit breaker operating handles but without access to any energized parts.

E. Flush mounted 208Y/120 Volt and 120/240 Volt single phase panelboards rated greater than 100A and all flush mounted 480 Volt panelboards: Furnish “door-in-door” trim.
1. Inner door with hinges and latch to cover access to circuit breaker operating handles but without access to any energized parts.
2. Outer door hinged on one side and secured on remaining sides with captive screws or screw driver operated latches. Provide door that provides full access to wiring gutter on all four sides when open.
3. Provide decorative trim around box to cover the gap between the enclosure and the wall surface.

4. Provide trim prepared, primed and painted in a light grey, ANSI 49 or similar color, at the factory.

F. Furnish Surface Mounted Panelboards with "Hinged Trim" Cover:
1. Inner door with hinges and latch to cover access to circuit breaker operating handles but without access to any energized parts.
2. Trim hinged at one edge of box and secured on remaining sides with captive screws or screw driver operated latches. Provide door that provides full access to wiring gutter on all four sides when open.
3. Provide trim prepared, primed and painted in a light grey, ANSI 49 or similar color, at the factory.

G. Furnish latched and lockable door with metal frame cardholder with clear plastic window on inside of door for panel directory.

H. Provide other features as shown on the Drawings or Schedules.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. General: Provide circuit breakers as integral components of panelboard with indicated features, ratings, characteristics, and settings.

B. Future Devices: Equip compartments with mounting brackets, supports, bus connections and necessary appurtenances for future circuit breakers as show on the Drawings or Schedules.

C. Molded-Case Circuit Breakers:
1. General: UL489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."
2. Suitable for use with conductors operating at 75° C.
3. Characteristics: Frame size, trip rating, number of poles, and short-circuit interrupting capacity rating as shown on the Drawings or Schedules.
4. Interrupting capacity not less than shown on the Drawings or Schedules. Furnish all circuit breakers with full interrupting capacity. Do not use series ratings.
5. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous over-current trip protection for each pole.
6. Adjustable instantaneous trip devices: Front adjustable; factory adjusted to low trip setting.
7. Solid state trip devices: When called for on the Drawings, provide molded case circuit breakers that use solid-state trip devices.
8. Furnish circuit breakers for lighting circuits that are switching duty rated.
9. Furnish heating, air conditioning, refrigeration (HACR) rated circuit breakers when called for on the Drawings or Schedules.
10. Furnish single pole circuit breakers with ground fault interrupting capability when called for on the Drawings or Schedules. When required furnish Class A (6ma.) or Class B (30ma.) as shown on the Drawings or Schedules.

D. Electronic Circuit Breaker Trip Devices: True RMS sensing, microprocessor based, solid-state overcurrent trip device system that includes one or more integrally mounted current transformer or sensor per phase, a release mechanism, and the following features:
   1. Temperature compensation to assure accuracy and calibration stability from -20°C to +55°C.
   2. Time-current tripping functions, field adjustable with the breaker closed and energized, as scheduled or shown on the Drawings, often abbreviated as L, S, I, and G.
      a. Adjustable long-time pick-up current.
      b. Adjustable long-time-delay.
      c. Adjustable short-time pick-up current.
      d. Adjustable short-time-delay.
      e. Adjustable instantaneous trip current.
      f. Adjustable ground-fault pick-up current.
      g. Adjustable ground-fault-delay.
      h. Selectable I2t function on short-time-delay.
      i. Selectable I2t function on ground-fault-delay.
   3. Clear, sealable cover over adjustments.
   4. Other factory options as shown on the Drawings or Schedules.
   5. Trip Indication: Labeled lights or mechanical indicators indicating long-time overload, short-time overload, instantaneous, or ground fault as cause of trip. If lights are used, furnish with integral power source capable of maintaining indication for not less than 48 hours.
   6. Arrangement to permit testing of all functions without removal from panelboard and to permit viewing and adjustment of all functions without removal of any metal panels.
   7. Furnish 80 percent rated circuit breakers unless otherwise shown on the Drawings or Schedules.

E. Ground Fault Protection Systems: If and as indicated on the Drawings or Schedules, provide zone selectively interlocked ground fault protection system using a single window type rectangular split core current transformer for each circuit and separate relays as specified in Section 26 28 20 – Zone Interlocked Ground Fault Relay Systems.

F. Other devices as shown on the Drawing or Schedules.

PART 3 EXECUTION

3.01 PANELBOARD INSTALLATION

A. Install panelboards following manufacturer’s instructions.

B. Mount panelboards plumb and rigid.

C. Mount flush panelboards so that the trim fits flat against finished wall.

D. For MLO panelboards, install compression lugs on conductors with press and die recommended by lug manufacturer. Bolt lug to bus.

3.02 IDENTIFICATION

A. Properly and accurately label panel directories by hand during construction.

B. Install neatly typed, accurate directories in holders prior to Substantial Completion.

C. Identify panelboard and its source with a nameplate.

3.03 KEYS

A. Keep panelboard keys properly marked and identified with panel number and location.

B. Furnish the Owner at least 2 copies of all panelboard keys, with tag showing identifying number and location of panel.

END OF SECTION

SECTION 26 27 16

CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Indoor and outdoor enclosures.

1.02 SUBMITTALS

A. See Specification Section 40 61 13 – Control System Documents and Procedures, Paragraph 1.04 for information on Submittals.

PART 2 PRODUCTS

2.01 CABINETS AND ENCLOSURES

A. National Electrical Manufacturers Association (NEMA) 4X outdoors, exterior shall be steel with white polyester powder paint or 316L SS for all outdoor panels that contain any type of electronics. NEMA 4X disconnect switches and other enclosures such as J-Boxes and Pull-Boxes are excluded.

B. NEMA 12 indoors. Other types allowed as noted on the Drawings.

C. Continuous hinged doors are required for all cabinets and enclosures 6 inch by 6 inch or larger. NEMA 4X enclosures 24 inch by 20 inch or larger shall have 3-point latch. Enclosures with clamps are not acceptable.

D. Padlockable.

E. nVent Hoffman or equivalent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Securely support independent of conduits.

B. Level in the vertical and horizontal.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wiring Devices: Switches, receptacles, covers.

1.02 SUBMITTALS

A. Complete manufacturer's catalog cuts.

PART 2 PRODUCTS

2.01 TOGGLE SWITCHES

A. Heavy-duty, "silent" AC type, 20 A, 120 VAC – 277 VAC.

B. Back and side wiring feature. Positive clamping with screw-activated pressure plate.

C. Poles and Contact Action: As shown on the Drawings.

D. Motor Switching Rated:
1. 1-1/2 horsepower at 120 VAC.
2. 2 horsepower at 240 VAC.

E. Manufacturers:
1. Hubbell HBL1221, HBL1222, HBL1223, HBL1224 series.
2. Pass & Seymour 20AC1, 20AC2, 20AC3, 20AC4 series.
3. Engineer reviewed equivalent.

F. Other features or switches as shown on the Drawings or Schedules.

2.02 DUPLEX RECEPTACLES

A. Commercial Grade Duplex Receptacle:
1. NEMA 5-15R.
2. Back and side wiring feature. Positive clamping with screw activated pressure plate.

B. Specification Grade Duplex Receptacle:
1. NEMA 5-15R.
2. Back and side wiring feature. Positive clamping with screw activated pressure plate.
3. Positive grounding without bonding jumpers.

C. GFCI Receptacle:
   1. NEMA 5-15R.
   2. Side wired.
   3. Flush polycarbonate face.
   4. Trip level: 4 to 6 mA.
   5. Trip time: .025 sec. nominal.
   6. Operating temperature: -35°C to +66°C.
   7. Hubbell GF5252A series, Leviton 6599 series, Pass & Seymour 1591 series, or Engineer reviewed equivalent.

D. Hospital Grade Duplex Receptacle:
   1. NEMA 5-15R.
   2. Back and side wiring feature. Positive clamping with screw activated pressure plate.
   3. Positive grounding without bonding jumpers.
   4. Marked with green dot on face.
   5. Hubbell 8200/8300 series, Leviton 8200/8300 series, Pass & Seymour 8200/8300 series, or Engineer reviewed equivalent.

E. All toggle switches and duplex receptacles: By same manufacturer. Other switches and receptacles are to be by the same manufacturer, except where shown by a different manufacturer in the Schedule or on the Drawings.

2.03 OTHER RECEPTACLES

A. Other devices as scheduled or as shown on the Drawings.

2.04 DEVICE PLATES

A. Proper for the device(s) installed.

B. Use a single plate for multiple devices.

C. Oversize Polycarbonate or Nylon:
   1. Premium grade.
   2. Match device color.
   3. Use on flush boxes in appropriate areas.
   4. Use standard size plate if oversized plate is not manufactured.
   5. Hubbell PJ series or Engineer reviewed equivalent.

D. Standard Size Polycarbonate or Nylon:
   1. Premium grade.
   2. Match device color.
   3. Use on surface-mounted boxes in appropriate areas.
   4. Use on flush boxes in appropriate areas if oversized plate is not manufactured.
   5. Same manufacturer, material, and appearance as oversize Polycarbonate or Nylon.

E. 302/304 Stainless Steel: Hubbell S1, or Engineer reviewed equivalent.

F. NEMA 7 in hazardous areas.

G. Telephone Plates: Match material and general appearance of other device plates in the area.

H. Special Plates: As scheduled or as shown on the Drawings.

I. Outdoor Toggle Switch Covers: Wet location lift cover, self-closing.

J. Damp Location Duplex Receptacle Cover and Box:
1. Single horizontal self-closing lid.
2. Die cast aluminum or polycarbonate.
3. UL listed as raintight in the closed position.
4. Meet NEC 406.8 (A).
5. Box: Designed for the specific cover and device combination and recommended by the cover manufacturer for use with the particular weatherproof cover.

K. Wet Location Duplex Receptacle Cover and Box:
1. Single horizontal self-closing.
2. Polycarbonate.
3. Paintable.
4. Other features as shown on the Drawings or Schedules.
5. UL listed as NEMA 3R with a cord connected.
6. Meet NEC 406.8 (B) (1).
7. Unless shown differently on the Drawings or Schedules, furnish Carlon E9UHG, TayMac 60310, or Engineer approved equivalent.
8. Box: Designed for the specific cover and device combination and recommended by the cover manufacturer for use with the particular weatherproof cover.

PART 3 EXECUTION

3.01 DEVICE COLOR

A. Special Colors:
1. Where scheduled.
2. Where called for on the Drawings.
3. Where manufacturer's or industry standard for device, such as orange for isolated ground receptacles and red for emergency power receptacles.

B. All others: White.

3.02 USAGE OF RECEPTACLES

A. Furnish GFCI Type Receptacles at Each Location:
1. Where required by NEC, or

2. Where scheduled, or
3. Where called for on the Drawings.

B. Unless shown otherwise on the Drawings or Schedules, use commercial grade receptacles as specified herein.

3.03 COVER TYPE

A. Wet Location, In-use: Outdoors and in process areas not excepted immediately below.

B. Damp Location: Indoor, above-grade process areas except spaces, such as blower rooms, that have no piping that carries sewage or sludge.

C. Stainless Steel: In laboratories, offices, meeting rooms, lobbies and other similar office/commercial type areas.

D. Standard Size Polycarbonate/Nylon or Galvanized Steel: Indoor surface-mounted device boxes.

E. Oversize Polycarbonate/Nylon: Indoor flush-mounted device boxes.

F. As scheduled or as called for on the Drawings.

3.04 INSTALLATION POSITION

A. Mount toggle switches at 42″ centerline above finished floor unless shown otherwise on the Drawings.

B. Indoors: Mount duplex receptacles at 18″ centerline above finished floor, unless shown otherwise on the Drawings.

C. Outdoors and In Areas Considered Wet Location: Mount duplex receptacles at 30″ centerline above finished grade or finished floor unless shown otherwise on the Drawings.

3.05 IDENTIFICATION

A. Mount nameplate above cover plate of each receptacle and switch.

B. Text:
1. Receptacles: Panelboard designation and circuit number(s). For example: “PP3-2, 4, 6” or “LP2IG-17.”
2. Switches: Circuit designation as above and description of lights controlled.
3. Otherwise as shown on the Drawings or Schedules.

END OF SECTION

SECTION 26 27 27

WIRE CONNECTORS AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wire connectors and accessories.

1.02 SUBMITTALS

A. If products from manufacturer and of the model shown in Part 2 are to be furnished, Submittals are not required and will not be reviewed.

B. If products from a different manufacturer or of a different model than shown in Part 2 are to be furnished:
   1. Submit complete manufacturer's cuts.
   2. Furnish other material demonstrating product equivalence as directed by the Engineer.

C. If a manufacturer and model are not shown in Part 2, furnish complete manufacturer's cuts.

PART 2 PRODUCTS

2.01 600V WIRE NUTS

A. UL listed and CSA certified for 600V maximum building wire, 1000V maximum fixture wire, 105°C maximum temperature rating.

B. Color coded outer shell to identify manufacturer approved wire combinations.

C. Nylon insulated.

D. Reusable.

E. Scotch 3M Ranger 312 or Ranger 512, or Engineer reviewed equivalent.

2.02 BUTT CONNECTORS

A. Non-insulated, brazed seam or seamless, compression type.

B. Insulation: Tubular pre-stretched EPDM rubber cold shrink insulators. 3M 8420 series or Engineer reviewed equivalent.

2.03 LOCKING FORK WIRE TERMINALS

A. UL listed and CSI certified.

B. One-piece burr-free electro-tin plated copper, locking fork style.

C. Ranges Required:
1. 22-18 AWG for 4, 6, 8, 10 studs.
2. 16-14 AWG for 4, 6, 8, 10, 1/4 studs.
3. 12-10 AWG for 6, 8, 10, 1/4 studs.

D. Barrel:
1. Silver-brazed seam.
2. Beveled opening to facilitate wire insertion.
3. Multiple V-grooves inside barrel for better wire retention.
4. Non-insulated.

E. Scotch 3M M18-4FL through M10-14FL or Engineer reviewed equivalent.

F. Installation Tool:
1. Hardened steel jaws and handles.
2. Color-coded, indent shape dies.
3. Compound lever action with a ratchet mechanism to insure positive closure for full crimping cycle.
4. Capable of being field adjusted to proper calibration.
5. Complete with operation, maintenance, and calibration instructions.
6. Scotch 3M TR-490 or Engineer reviewed equivalent.

2.04 SMALL RING TONGUE WIRE TERMINALS

A. Same as 2.04 except ring terminal.

B. Scotch 3M M18-4R/S through M10-12R or Engineer reviewed equivalent.

C. Installation Tool: Scotch 3M TR-490 or Engineer reviewed equivalent.

2.05 LARGE RING TONGUE WIRE TERMINALS

A. Same as 2.04 except ring terminal in sizes from #8 to #4/0 AWG for 3/8, 1/2 studs.

B. Thomas and Betts StaKon D through L or Engineer reviewed equivalent.

C. Installation Tool: T&B TBM6 or TBM6S or Engineer reviewed equivalent.

2.06 AREA LIGHTING CONNECTION KIT

A. Complete kit with Allen set screw multiple connector blocks; separable, crimp-on wire terminals; UV stabilized waterproof multiple entry boot; fuse holder and fuse for branch circuit.

B. Buchanan 82S series or Engineer reviewed equivalent.

2.07 MEDIUM DUTY TERMINAL BLOCKS

A. UL component recognized.

B. Voltage Rating: 600V UL.

C. Material: Nylon with elevated marking strip.

D. Spacing: 0.375” center to center.

E. Contacts:
1. Electrical grade copper alloy.
2. Tubular clamp type.
3. 40A.

F. Wire Range: #22 to #10 AWG.

G. Maximum Service Temperature: 105°C.

H. Buchanan #0715, #0730, #64, #68, #99, and #52, or Engineer reviewed equivalent.

2.08 HEAVY DUTY TERMINAL BLOCKS

A. UL component recognized.

B. Voltage Rating: 600V UL.

C. Material: Nylon with elevated marking strip.

D. Spacing: 0.5” center to center.

E. Contacts:
1. Electrical grade copper alloy.
2. Tubular clamp type.
3. 70A

F. Wire Range: #18 to #6 AWG.

G. Maximum Service Temperature: 125°C.

H. Buchanan #0243; #0250; #64; #68; #99; and #52, or Engineer reviewed equivalent.

2.09 POWER DISTRIBUTION BLOCKS

A. UL component recognized.

B. Tin plated high conductivity aluminum.

C. Main and branch conductor size and number as shown on the Drawings or Schedules.

D. Number of poles as shown on the Drawings or Schedules.

E. Manufacturers:
1. Square D: Class 9080 – Type LB.
2. Cooper/Bussman: 16 Series.
3. Engineer reviewed equivalent.

2.10 DIN RAIL-MOUNTED CONTROL TERMINAL BLOCKS

A. General:
1. Comply with UL standards 486 and 1059.
2. Termination:
   a. Box type clamp in which a screw applies continuous pressure to a plate which compresses the wire against the current bar, or
   b. An automatic wire clamping system design to increase the clamping force as force is applied to pull the wire out of the clamp. Furnish clamping system with minimum retention forces (lbs) not less than shown in the following table:

Wire Size	Type of Wire	
AWG	Solid	Stranded
14	20.5	13.5
12	31.5	20.5
10	38.5	23.0
8	69.0	41.0

3. Accept solid or stranded wire, or stranded wires with ferrules.
4. Mount on standard TS 35 DIN-rail.

B. Terminal Blocks, 600V Rating:
1. Digital and analog signals: 6mm spacing (.238”), for 22-10 AWG wire.
   a. DC positive or supply: Grey body.
   b. DC negative or return: Blue body.
2. DC shield and drain wire: 6mm spacing.
   a. Terminals insulated from ground: Yellow body.
   b. Terminals grounded to rail: Yellow body with green stripe.
3. AC signal or power: 8mm spacing (.315”), for 22-8 AWG wire.
4. AC foreign voltage, where circuits remain live after opening of control voltage disconnect switch: 8mm spacing, orange body.
5. AC equipment ground, terminals grounded to rail: 8mm spacing, yellow body with green stripe.

C. Switch Terminal Blocks:
1. DC: 6mm spacing, short-hinged blade, grey body, orange blade.
2. AC: 8mm spacing, long hinged blade, grey body, orange blade.

D. Fuse-Holder Terminal Blocks:
   1. DC or AC: Fused switch style, for 6.35x32mm (1/4" x 1-1/4") fuses, greater than 13mm (.512") spacing, with blown fuse indicator.
   2. Self-contained without the need for an end cover.

E. Other terminal blocks as shown on the Drawing or Schedules.

F. Accessories:
   1. Mounting rails: Bichromated zinced steel or anodized copper.
   2. End sections for blocks: Required on the open extremity of each size and style of terminal block.
   3. Circuit Separator: Required between blocks of different voltages, power and control, AC and DC.
   4. End stops for rails: Required at the extremities of each series of terminal blocks.
   5. Jumpers: Required for jumpering between blocks. Either a. or b. as below, or as specified on the Drawings.
      a. Comb type.
      b. Bar type.

G. Markers: Required for every terminal block and board.
   1. Terminal block: Side mount, pre-printed vertical or horizontal to match board alignment. Coordinate abbreviations of text with Engineer if descriptor exceeds available space.
   2. Terminal Board: End stop marker holder.

H. Test Devices and Plugs: Provide during testing, and leave with the project spares the following items:
   1. Screw head test receptacle for 6mm blocks (if used): Four each.
   2. Screw head test receptacle for 8mm blocks (if used): Four each.
   3. Test plugs for the above receptacles: Eight each.

I. Manufacturers:
   1. Phoenix Contact.
   2. Wago.
   3. Engineer reviewed equivalent.

2.11 CABLE GRIPS

A. Material: 302 or 304 stainless steel.

B. Heavy duty unless shown otherwise on the Drawings.

C. Single offset eye unless shown otherwise on the Drawings or otherwise submitted and reviewed.

D. Basket weave, rod closure, reusable.

E. Hubbell Kellems or Engineer reviewed equivalent.

2.12 CONNECTORS FOR DEVICENET™

A. Comply with ODVA™ standards.

B. Provide connectors which are designed so disconnection of a device does not disrupt the network and as shown on the Drawings.

C. Provide drop line connectors/connections to match end devices.

PART 3 EXECUTION

3.01 WIRE NUTS

A. For splices on copper conductors #8 AWG and smaller.

B. Consult manufacturer's instructions for approved wire nut based on combination of wires being spliced.

C. Do not use for splices that may become submerged, such as in manholes, handholes, underground pull boxes, and wet wells.

D. Do not use for control or instrumentation conductors.

3.02 COMPRESSION TYPE CONNECTORS

A. Use only the tool and die specified by the manufacturer for installation.

3.03 BUTT CONNECTORS

A. For splices on 120, 240, 480V circuit conductors #6 AWG and larger (except at motors). Use only where specifically required on Drawings.

3.04 MOTOR LEAD CONNECTORS

A. Solid wire: 600V wire nuts.

B. Stranded Wire:
1. Install non-insulated, brazed seam or seamless, ring terminal compression lugs on each conductor, then bolt together.

C. Insulate with Scotch 5300 - 5204 Series pigtail kits, or Engineer reviewed equivalent.

3.05 MARKING OF TERMINAL BOARDS AND TERMINALS

A. DIN-Rail Mounted Terminal Systems: See Part 2.

B. Other Terminal Boards:
   1. Engraved Micarta nameplate with 1/8” letters.
   2. Adjacent to each row or column of terminals.
   3. Text: As shown on Drawings or submittals.

C. Terminal Points:
   1. Mark each terminal that will be wired.
   2. Mark other terminals if so shown on Drawings.
   3. Text: As shown on Drawings or submittals; if not shown, then match wire number.

3.06 INSTALLATION, ORIENTATION, AND CONNECTION OF DIN RAIL TERMINALS

A. Mount switch and fuse-holder terminal blocks so the blades will fall open, with the hinge at the bottom if blocks are mounted vertically (horizontal rail).

B. Connect switch and fuse-holder terminal blocks so the blade is de-energized; i.e., with voltage on the non-hinged side and load on the hinged side.

C. Install DIN rails with empty space for one future block for each ten installed, except that no rail shall have fewer than four empty spaces for the largest block used.

D. Attach DIN rails each 15 cm (6”).

E. Other devices such as relays, surge protectors, power terminals, and interface modules may occupy the same rail as terminal blocks.

END OF SECTION

SECTION 26 28 13

LOW VOLTAGE FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

B. Fuse blocks and holders.

1.02 SUBMITTALS

A. Catalog cuts.

B. Time-current characteristic curves.

C. Current limitation curves.

D. Operating temperature characteristics.

E. Submit only for the types of fuses, blocks, and holders required by the Drawings.

1.03 EXTRA MATERIALS

A. Section 26 00 60 – Extra Materials for Electrical Systems.

PART 2 PRODUCTS

2.01 CURRENT LIMITING, DUAL-ELEMENT, TIME DELAY FUSES

A. Time Delay: 10 seconds minimum at 5 times rated current.

B. Note Well: Overload portion of dual element shall open at a temperature not greater than 300°F.

C. Interrupting Rating at rated voltage: 300,000A RMS symmetrical.

D. UL Class RK-5.

E. 250 VAC: Bussmann Fusetron FRN-RK_SP or Engineer reviewed equivalent.
600 VAC: Bussmann Fusetron FRS-RK_SP or Engineer reviewed equivalent.

2.02 FAST CURRENT LIMITING, DUAL-ELEMENT, TIME DELAY FUSES

A. Time Delay: 10 seconds minimum at 5 times rated current.

B. Note Well: Overload portion of dual element shall open at a temperature not greater than 300°F.

C. Interrupting Rating: 300,000A RMS symmetrical.

D. UL Class RK-1.

E. 250 VAC: Bussmann Low Peak LPN-RK or Engineer reviewed equivalent.
600 VAC: Bussmann Low Peak LPS-RK or Engineer reviewed equivalent.

2.03 HIGH AMPACITY, FAST CURRENT LIMITING, TIME DELAY FUSES

A. Open at 150 percent of rated current within 4 hours.

B. Time Delay: 4 seconds minimum of 5 times rated current.

C. Interrupting Rating: 300,000A RMS symmetrical.

D. U.L. Class L.

E. 600 VAC: Bussmann Low-Peak KRP-C or Engineer reviewed equivalent.

2.04 CONTROL TRANSFORMER PRIMARY AND INSTRUMENT FUSES

A. Open at 135 percent of rated current within 1 hour.

B. Time Delay: 4 seconds minimum at 3 times rated current.

C. Interrupting Rating: 200,000A RMS symmetrical.

D. UL Class CC, with rejection feature.

E. 600 VAC: Bussmann CC-Tron FNQ-R or Engineer reviewed equivalent.

2.05 SMALL DIMENSION CONTROL CIRCUIT FUSES

A. Bussmann AGC, ABC, MDL, MDQ, MDX, or Engineer reviewed equivalent, to match current and voltage of circuit. Use dual-element fuses unless recommended otherwise by equipment manufacturer or shown as fast acting on the Drawings.

2.06 REJECTION FUSE BLOCKS FOR 2.01 AND 2.02 FUSES

A. Base: Phenolic.

B. Box terminals.

C. Bussmann Class R Phenolic or Engineer reviewed equivalent.

2.07 REJECTION FUSE BLOCKS FOR 2.04

A. Base: Phenolic.

B. Copper alloy box terminals.

C. Bussmann BC603-1B, BC603-2B, BC603-3B, or Engineer reviewed equivalent.

2.08 REJECTION FUSE HOLDERS FOR 2.04

A. Body: Phenolic, with mounting holes for bolting to panel, and screw knob.

B. Combination 1/4 inch quick connect/solder terminals.

C. Bussmann HPF-RR or Engineer reviewed equivalent.

2.09 FUSEHOLDERS FOR 2.05

A. Body: Phenolic with bayonet knob.

B. Voltage Rating: 250 V

C. Maximum fuse size: 20 A

D. Terminals: 1/4” right angle quick connect.

E. Bussmann HTB-48I or Engineer reviewed equivalent.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

A. Enclosed switches.

B. May also be referred to as disconnect switches, safety switches, and/or service disconnects switches.

1.02 SUBMITTALS

A. Not required.

PART 2 PRODUCTS

2.01 ENCLOSED SWITCHES

A. Type of Enclosure: See Paragraph 3.02.

B. Service Disconnect Switches: 3 pole plus neutral and ground. Other switches: 3 pole plus ground unless neutral is required by the Drawings.

C. 600 Volt unless shown otherwise on the Drawings.

D. Ampere Rating: As shown on the Drawings.

E. Heavy duty, padlockable to the off position.

F. Switch Mechanism: Positive action quick-make, quick-break, with visible blades.

G. Non-fusible: Where shown on Drawings.

H. Fusible:
1. Where shown on Drawings.
2. Fuse clips reject all except Class R current limiting fuses.

I. Provide electrical interlock kits, as shown in the Drawings, on those switches through which the control circuit wiring is routed. The kit shall have 1 NO and 1 NC contact rated 10 A resistive and 6 A inductive or 2 NO where noted. The contacts, when actuated, shall break the control circuit before the safety switch opens.

J. Switches with non-metallic NEMA 4X enclosures: Square D Class 3110 Krydon® or Engineer reviewed equivalent.

K. Switches with NEMA 1, 3R, 12, 4X SS enclosure: General Electric Type TH, Cutler-Hammer DH, Square D Class 3110, or Engineer reviewed equivalent.

L. Switches with NEMA 7, 8, or 9 enclosure: Crouse Hinds FLS, or Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 MARKING

A. Furnish engraved nameplate on each switch.

B. Text as shown on the Drawings, but if not shown, then:
   1. Source of power to the switch, example "Fed From MCC1."
   2. Name and Tag Number of equipment served, example "Influent Lift Pump 1, PMP1011."

3.02 TYPE OF ENCLOSURE

A. Comply with the matrix which is appended to this Section.

B. If not shown in matrix, comply with requirements shown on Drawings.

C. If not shown in either place, then:
   1. NEMA 1 in indoor non-process areas, such as: blower rooms, electrical rooms, administration building offices and mechanical rooms.
   2. NEMA 4X non-metallic in indoor process areas where there is liquid piping but no open liquid, such as a room with sludge pumps.
   3. NEMA 4X SS in indoor process area where there is open liquid, such as a membrane basin.
   4. NEMA 3R outdoors in areas more than 100 feet from a primary/secondary process structure. This includes structures containing raw or partially treated sewage but not a UV disinfection structure.
   5. Stainless steel NEMA 4X in all other indoor and outdoor areas, including but not limited to areas less than 100 feet from a primary/secondary process structure.
   6. Regardless of any/all other requirements above: NEMA 7 in classified (hazardous) areas, whether indoors or outdoors.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable frequency drives (VFDs) and appurtenances.

1.02 SUBMITTALS

A. Product data.

B. Ratings and features.

C. Elevation and footprint views.

D. Schematic and internal connection diagrams.

E. Submit calculations for site de-ratings of all VFDs being provided.

F. VFD manufacturer's published engineering procedures for derating calculations.

G. Recommended Spare Parts List:
1. Name/function of part.
2. Catalog number.
3. Quantity recommended.
4. Cost (each) if bought under change order to Contract.
5. Future source of supply, local to project if available.

H. Certification of Manufacturers:
1. Experience.
2. ISO 9001 status.

I. For VFDs mounted in MCCs, provide submittals for VFD as part of MCC Submittal.

1.03 OPERATION AND MAINTENANCE DATA

A. Product data.

B. Ratings and features.

C. Elevation and footprint views.

D. Schematic and internal connection diagrams.

E. One complete set of drawings in AutoCAD .DWG format and in .DXF format on DVD.

F. Manufacturer's standard Operation and Maintenance (O&M) Manual with troubleshooting guide and parts list.

1.04 QUALITY CONTROL

A. All standard VFDs, all options, all assemblies: UL listed and labeled and/or CSA certified/labeled.

B. Provide VFDs which bear CE Marks meeting the following directives:
1. Machine directive, 89/392/EEC.
2. Low voltage directive, 73/23/EEC.
3. EMC directive, 89/336/EEC.

C. Provide VFDs which comply to the following EMC (Electromagnetic compatibility) standards, as applicable to the input power, output power and control inputs/outputs:
1. Conducted Emission – EN55011, Class A Group 1 or Class B Group 1 as applicable (150 kHz – 30 MHz).
2. Radiated Emission – EN55011, Class A Group 1 (30 MHz – 1000 MHz).
3. Immunity – EN 61000-4-2 Electrostatic discharges (ESD).
4. Immunity – EN 61000-4-3 Radiated electromagnetic field, 1 kHz, 80% amplitude modulated (80 MHz – 1000 MHz).
5. Immunity – EN 61000-4-4 Burst transients 5/50 μS.
6. Immunity – EN 61000-4-5 Surge transients 1,2/ 50 μS.
7. Immunity – ENV 50204 Radiated electromagnetic field, pulse modulated (900 MHz ± 5 MHz).
8. Immunity – EN 61000-4-6 Radio Frequency Common Mode Voltage 1 kHz, 80% amplitude modulated (150 kHz – 80 MHz).
9. Immunity – VDE 0160 Section 7.3.1.1 Class W2 Test Pulse: Mains transients.

D. VFD Manufacturer:
1. ISO 9001 certified and ISO 14001 certified.
2. Demonstrate a continuous period of manufacture and development of VFDs for at least 10 years.

1.05 SOURCE

A. Obtain drive from a factory authorized representative/distributor which provides local sales, parts, technical, and warranty support, and which employs factory authorized and trained personnel.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVE (VFD)

A. Major Components:
1. AC line disconnect, lockable, door interlocked, if scheduled or shown on the Drawings. Most drives for this project do not require internal disconnects.
2. AC input fuses for protection of AC to DC converter.

3. VFD bypass circuit if scheduled or shown on the Drawings.
    a. Drive input isolation: Manual 480V switch with auxiliary contacts or IEC contactor as shown on Drawings.
    b. Drive Output Isolation: IEC contactor, sized to match drive output rating.
    c. Bypass contactor: NEMA starter with electronic overload relay, size as scheduled.
    d. Provide separate compartments and configure components such that it is possible to run the motor in bypass mode while having absolutely no voltage above 24 VDC present in the VFD compartment.
4. Phase to phase and phase to ground transient protection on input. Comply with the requirements of EN 6100-4-4 Burst Transients and EN 6100-4-5 Surge Transients.
5. AC to DC converter with AC reactor or DC choke to limit inrush and reduce harmonics.
6. DC to AC Converter:
    a. Provide adjustable frequency pulse width modulated (PWM) synthesized sine wave output.
    b. Use IGBT devices which are protected against over-voltage, over-current, over-temperature, and reverse voltage.
    c. SCR, GTO, or thyristor devices are not acceptable.
    d. Set carrier frequency to the lowest available unless a higher frequency is recommended by the manufacturer and allowed by the Engineer. Coordinate output filter selection with carrier frequency.
7. Provide drive output protection such that short circuit or ground fault on the motor leads does not damage the drive.
8. Motor Overload Protection:
    a. Drives with Bypass: Provide a separate solid-state overload relay.
    b. Drives without Bypass: Provide a separate solid-state overload relay or provide speed sensitive solid state motor overload protection integral to the drive electronics.
9. Control power transformers for drive itself, for bypass contactors, and for others loads as shown on the Drawings. Provide extra VA capacity as scheduled or shown on the Drawings.
10. Provide additional controls as shown on the Drawings.
11. 24 VDC power supply with 400 mA available for use by Owner's controls.
12. VFD to include a Low Harmonic Filter.

B. Efficiency:
1. Minimum efficiency at 100% load: 96%.
2. Minimum efficiency at 20% load: 92%.

C. Input Voltage as scheduled or shown on the Drawings:
1. 208V 3 phase nominal, self-adjusting for 200-240V ±10% input, or
2. 460V 3 phase nominal, self-adjusting for 380-480V ±10% input.
3. 120V single phase.
4. Displacement Power Factor: 94% or greater from no load to full load.

D. Output Voltage: Zero to line voltage, to match input, 3 phase, 0 to 120 Hz, variable voltage (volts/Hertz) up to 60 Hz, constant voltage above 60 Hz. However, for drives which power positive displacement pumps or blowers, provide sensorless vector control capability.

E. Output Frequency Control Options:
   1. Manual speed control by means of keypad or front-panel mounted potentiometer.
   2. Speed control by a 4 to 20 mA signal into input port which is isolated from AC power, ground, and drive electronics internal power and ground:
      a. Direct control of frequency,
      b. PID control for closed loop speed regulation, closed loop process control, or open loop torque control.
   3. Features, such as programmable hardware inputs, to allow control of frequency as:
      a. Above choices,
      b. Preset frequencies,
      c. Commanded over communications link.

F. Skip Frequencies:
   1. Provide three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance.
   2. Provide set points with bandwidth adjustable from 0 to 60 Hz.

G. Flying Start: Provide capability of determining the speed and direction of a spinning motor and automatic adjustment of VFD output so it can "pick-up" the motor at the rotating speed.

H. Provide a drive which has the NP horsepower rating and minimum output current capacity scheduled, after the drive is derated for altitude and ambient temperature, not just large enough for the HP of equipment shown on the Drawings.

I. Duty Rating:
   1. Where scheduled below, provide drives that are rated standard duty "variable torque" and which can provide at least 110% of scheduled minimum current capacity for at least 1 minute out of 5 minutes.
   2. All other drives: Heavy duty "constant torque" which can provide at least 150% of scheduled minimum current capacity for at least 1 minute out of 5 minutes.

J. Operator Interface Panel:
   1. Liquid Crystal Display: Minimum two lines of 16 characters.
   2. Full numeric keypad plus navigation and "enter."
   3. As a minimum, use for adjustment of drive parameters, including transfer of drive setup from one drive to another, and display of drive operations as selected by facility Operator.
      a. Minimum frequency and maximum frequency.
      b. Multiple acceleration and deceleration ramps.
      c. Three bypass frequencies with adjustable bandwidths.
      d. Preset speeds.
      e. Current limit.

f. Low speed and high speed load compensations.
g. Slip compensation.
h. Magnetization current.
i. PID parameters and feedback scale factor.
j. Warning current High/Low.
k. Warning frequency High/Low.
l. Warning feedback High/Low.
m. Power loss ride through mode.
n. Flying start mode.
o. DC Braking:
    1) Time,
    2) % current,
    3) Cut-in frequency.
p. Motor Parameters:
    1) kW (HP),
    2) Voltage,
    3) Frequency,
    4) Full load current,
    5) Base RPM.
q. Diagnostics:
    1) Display a minimum of the last four fault events.
    2) Display other diagnostic parameters.
r. Display of Drive Operations at Operator Request:
    1) Reference signal [%].
    2) Reference signal [unit].
    3) Feedback [unit].
    4) Frequency [Hz].
    5) Motor current [A].
    6) Torque [%].
    7) Power [kW].
    8) Power [HP].
    9) Energy [kWh].
    10) Motor Voltage [V].
    11) DC link voltage [V].
    12) Thermal load, motor [%].
    13) Thermal load, VFD [%].
    14) Run hours [hrs].
s. Jam protection parameter programmable to trip drive above a current set-point with definite time delay, active only after initial acceleration of load.
t. Selection of automatic restart on power outage and return or for restart only after the operator intervenes. Unless scheduled otherwise, provide automatic restart setting.
u. Manual stop-start control, coordinated with hardware controls.
v. Adjustment of running current limit protection: 10% to 110%. Unless requested otherwise by Engineer, set for 105%.
w. Adjustment of acceleration time: 0.1 to 3,600 seconds. Unless requested otherwise by Engineer, set for 15 seconds.

x. Selection of remote (mA) or manual control of frequency coordinated with hardware controls.
y. Manual adjustment of frequency.
z. Selection of action upon detection of loss of 4-20 mA signal:
1) Switch the VFD to the last speed, full speed, jog speed, preset speed.
2) Stop and trip.

K. Minimum four programmable discrete inputs. Provide more if needed in order to implement all designed functions.

L. Parameter Storage:
1. Store the factory default settings in VFD resident non-volatile memory (EEPROM) so that the user can return the drive to a known state.
2. Store the actual, in-use, program in VFD EEPROM.

M. Drive and Motor Protection:
1. Shutdown for:
a. Input overvoltage, undervoltage, or voltage unbalance,
b. Overheating of the drive,
c. Other internal drive faults,
d. Motor overload or fault.
2. Provide dry alarm contact.
3. Restart only after operator intervenes unless programmed for automatic restart on power return.
4. VFD shall come with certified shielded VFD cables with proper length to allow installation from the VFD to the pump motor.

N. Furnish controls and terminal boards for interface to other plant equipment as shown on the Drawings.

O. Provide isolated dry contacts for alarm and control:
1. Programmable as to function.
2. Two Form A (SPST, NO) contacts, and
3. Two Form C (SPDT) contact sets.

P. Provide other control as scheduled or shown on the Drawings.

Q. Ethernet Communication:
1. Each VFD shall be supplied with a means to communicate via Ethernet/IP network.
2. Ethernet connections shall be configured in a star architecture to connect all VFD devices back to a common point of connection for the supervisory control system. Star cabling runs shall consist of a single cable from the devices back to an Ethernet switch. The powering down of a VFD device shall not affect the performance of other device communications.

R. Approved manufacturers: VFDs shall be ABB ACQ580 ULH, no substitution.

PART 3 EXECUTION

3.01 MARKINGS

A. Furnish nameplate on each VFD identifying equipment served. Show name of equipment, tag number, and source of power.

3.02 STARTUP SERVICE

A. Provide services of a field service representative of the VFD manufacturer to:
1. Verify correctness of field installation.
2. Completely test all pertinent functions.
3. Adjust drive parameters.
4. Place drive in service.
5. Adjust/re-adjust drive parameters and/or PI controls as requested by Engineer.
6. Train Owner personnel.

3.03 FLOW MEASUREMENTS AND SETTINGS DURING STARTUP

A. Determine the speed required for flow operation controls during startup.

3.04 OTHER REQUIREMENTS

A. Enclosure: NEMA 1.

B. Ambient:
1. Altitude: 6,900 feet above MSL.
2. Maximum Temperature: 40°C.

C. Additional control features required for this project.
1. Controls as shown on the Drawings.
2. In submittals, show all control components, not just those at the VFD. Show internal and external wiring.
3. Proportional/Integral (PI) control for closed loop speed regulation, closed loop process control, or open loop torque control.
4. Extra VA capacity of control power transformer where indicated.
5. Provide communications port and firmware/software for connection to and correct interoperation with the plant PLC network, if applicable.

D. Contractor to provide 1 hour of training for operations and maintenance personnel on the setup and operation of the VFD. Use the section of the O&M Manual dealing with the VFD along with any other information required to properly instruct the staff on how the drive was programmed and what to do if changes to setpoints are desired.

END OF SECTION

SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. True on-line double-conversion uninterruptible power supply.

B. Software and accessories for communications with a personal computer.

1.02 SUBMITTALS

A. Catalog cuts for hardware and software.

B. Dimension drawings.

C. Exact battery manufacturer, type, model, and quantity. If batteries are labeled as being a product of the system manufacturer but are in fact manufactured by a different company, provide the same information for the actual manufacturer.

1.03 O&M MANUALS

A. Manufacturer's O&M Manual.

B. Original, printed, bound manual. Xerographic copies are not acceptable.

C. If so published, provide two copies on CD in Adobe™ pdf format.

D. Include manuals for hardware and software.

E. Provide interface software on CD.

F. Exact battery manufacturer, type, model, and quantity. If batteries are labeled as being a product of the system manufacturer but are in fact manufactured by a different company, provide the same information for the actual manufacturer.

1.04 EXTRA MATERIALS

A. Fuses: Two complete sets.

PART 2 PRODUCTS

2.01 UNINTERRUPTIBLE POWER SUPPLY

A. Standards:
1. UL and CSA listed/labeled.
2. EMC: Comply with FCC Class B.
3. Surge Suppression: Tested to withstand IEEE\/ANSI C62.41 Category B wave.

B. Architecture:
1. Double-conversion.
2. Rectifier/battery charger.
3. Inverter which operates continuously, supplying all of the load power.
4. Output isolating transformer.
5. Static bypass switch.
6. Designed to completely isolate the output power from outages, sags, surges, spikes, brownouts, line noise, frequency variation, switching transients, and harmonic distortion.

C. Environmental:
1. Except for batteries: 0 to 40°C.
2. Batteries: 0 to 25°C.
3. 0 to 90% relative humidity.
4. Maximum noise produced:
   a. 45 bDA with input present,
   b. 50 dBA while operating on battery.

D. Electrical Input:
1. 120 V RMS nominal.
2. 80 V to 144 V without using battery.
3. Power Factor: Greater than 0.95.
4. Frequency: 55 to 65 Hertz.
5. Maximum current: as required in the Schedule.

E. Electrical Output:
1. 120 V RMS nominal, single phase.
2. Voltage regulation, input present: ± 3% of nominal.
3. Voltage regulation, input absent: ± 3% of nominal.
4. Efficiency 89% to 92%, load-dependent.
5. Frequency:
   a. 57 to 63 Hertz, following input.
   b. 59 to 61 Hertz, input absent.
6. Load crest factor (peak over RMS): up to 3 to 1.
7. Output VA and Watt rating: as required in the Schedule.

F. Operation when powered from a generator:
   1. Must operate completely normally from 57 to 63 Hertz.
   2. Must operate properly, perhaps on inverter, while still charging battery, from 55 to 65 Hertz.

G. Batteries:
   1. Sealed. Maintenance free.
   2. Hot-swappable.
   3. Minimum run-time on battery: as required in the Schedule.

H. Physical:
   1. Steel case.
   2. Fan-cooled.
   3. Suitable for mounting on one edge, such as when on or below as desk.
   4. Suitable for mounting flat, such as in a rack or one a shelf.
   5. Line cord with NEMA 5-15P cap.
   6. Six NEMA 5-15R output receptacles.
   7. LED indicators for input present, nominal percent load, battery failure, no ground connection, high temperature, overload, on battery.

I. Miscellaneous:
   1. Execute full system self-test on power up.
   2. Automatic operation of static bypass for high load and/or UPS failure.
   3. RS-232 communications port: standard, complete with 6' cable.
   4. In and out jacks for protection of 10/100 Base-T network cables, tested to UL497A.
   5. Relay outputs for alarm and for shutdown.

J. Companies which may have products which meet this specification: Powerware, Toshiba, MGE.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as shown on the Drawings.

B. If the UPS is providing power to a personal computer, connect communications cable, install UPS software on the PC, and configure:
   1. Provide warning of impending UPS shutdown,
   2. Then shut down the PC before the UPS shuts down.

C. If the UPS is providing power to a programmable logic controller, connect UPS output alarm and impending shutdown contacts as inputs to the PLC.

D. Install nameplate with the below information:
   1. Identification number, such as UPS-2.
   2. Input voltage, phase, frequency.
   3. Output voltage, phase, frequency.
   4. Battery voltage, battery quantity, and bank voltage.
   5. Load(s) served.

3.02 SCHEDULE

A. Maximum 1800VA input while supplying rated output watts and recharging the batteries from flat.

B. Rated output: 1500VA/1050 Watts.

C. Run-time on battery when new:
   1. 700VA/490W: 25 minutes.
   2. 1000VA/700W: 16 minutes.
   3. 1500VA/1050W: 8 minutes.

D. Run time after batteries have been in service:
   1. Minimum run time at 67% load after 32 months of service: 82% of new.
   2. Minimum run time at 67% load after 58 months of service: 70% of new.
   3. Minimum run time at 67% load after 69 months of service: 42% of new.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices for low voltage electrical power systems.

1.02 SUBMITTALS

A. Manufacturer’s literature, including rating information.

1.03 O&M MANUAL

A. List of suppressors used on this project with manufacturer's name, SPD type, part (catalog) number, and (for each part so provided) serial number. The use of a generic or typical part number will not be acceptable. Provide the part number which was used to order the part with all choices and options included. If a part number is given on a nameplate on the actual part, then include that number on this list. If the ordering number and the nameplate number differ, include both numbers and explain the difference.

PART 2 PRODUCTS

2.01 SURGE PROTECTIVE DEVICES (SPD): COMMON REQUIREMENTS

A. Comply with the requirements of:
1. UL 1449 – Third Edition.
2. IEEE C62.41 – Location/exposure Categories below refer to this standard.
3. IEEE C62.45 – For test methods.
4. ISO 9001 – 2000 certified.

B. Testing:
1. Performed by an independent testing laboratory.
2. Test as a complete unit. Testing of the surge current capacity of a single MOV or SAD and extrapolation of overall rating from that is not acceptable.

C. Voltage: As shown on the Drawings.

D. Surge Capacity: As shown on Drawings or Schedule.

E. Protection modes for units installed at service equipment and at the transformer or first panelboard of a separately derived system: Line to neutral and line to ground.

F. Protection modes for units installed downstream of the above units: Line to neutral, line to ground, and neutral to ground.

G. Repetitive Impulse: 5,000 hits.

H. Response Time: Less than 1 nanosecond.

I. Voltage Protection Rating, (VPR – 3kA): Not more than shown in the following table using tests as defined in UL1449 – Third Edition.

Voltage	Type	L-N	L-G	N-G	L-L	In	SCCR	MCOV
208/120	1	700	700	700	1000	20kA	200kA	150
480/277	1	1200	1200	1200	1800	20kA	200kA	320
480V Delta	1	-	1800	-	2000	20kA	200kA	550
240/120	2	330	-	330	700	10kA	200kA	150

J. Environmental:
1. Temperature: -25°C to +60°C.
2. Humidity: 0% to 95%, non-condensing.

K. Internally protected against short-circuit and overload. Suitable for connection to the circuit which it is protecting by means of a molded-case switch.

L. Warranty:
1. Type 1: 10-year full replacement warranty.
2. Type 2: 5-year full replacement warranty.

M. Enclosure as shown on the Drawings.

N. Hard-wired.

O. Where sine wave tracking is required in "Type" paragraphs below, provide hybrid design incorporating filters, capacitors, or other technology in addition to MOVs and SADs to remove low voltage high frequency disturbances at any phase angle that will limit the let-through voltage of an A1 Ring Wave voltage relative to the applied 60 Hz voltage to not more than shown in the following table.

P. Other Features:
1. LED indication of operational state of suppressor for each phase/mode.
2. Modular plug-in suppressor units for easy replacement.
3. Symmetrically balanced metal oxide varistors (MOV).
4. As required in "Type" paragraphs below.
5. As shown on the Drawings or Schedule.

2.02 TYPE

A. Surge Capacity of 250kA and greater:
1. High surge current device designed for service equipment and rated for location/exposure Category C3.

2. Features: Dry form C contact for external alarm indication.

B. Surge Capacity greater than 100kA and less than 250kA:
1. High surge current device designed for service equipment and rated for location/exposure Category C3.
2. Features: Dry form C contact for external alarm indication.
3. Sine wave tracking.

C. Surge Capacity of 100kA or less:
1. Sine wave tracking.
2. Dry form C contact for external alarm indication, only if shown on the Drawings or Tag List.

PART 3 EXECUTION

3.01 INSTALLATION OF HARD-WIRED SPD

A. Plan the installation in advance so that an SPD is installed immediately adjacent to (above, left, right, or below) the protected equipment.

B. Connect to circuit being protected by means of a molded case switch (non-automatic circuit breaker) or circuit breaker as shown on the Drawings.

C. Connect SPD with minimum #8 stranded wire or as shown on the Drawings, whichever is greater. If manufacturer recommendation is different, the Engineer will resolve conflicts.

D. Make connecting conductors as short as practical: Maximum 24 inches. Sharp bends in conductors are not acceptable. If the configuration of the SPD is such that shorter lead length can be achieved by mounting the enclosure rotated 90 or 180 degrees from “normal” then do so if allowed by the manufacturer of the SPD. Do not mount with hinge on bottom.

3.02 SCHEDULE

A. Type and surge capacity as shown below unless shown otherwise on Drawings.
1. 480V Switchboards: Type 1, 250kA surge capacity.
2. 480V MCCs: Type 1, 150kA surge capacity.
3. 480V Panelboards: Type 1, 150kA surge capacity.
4. 208/120V Panelboards: Type 2, 80kA surge capacity.
5. 240/120V Panelboards: Type 2, 80kA surge capacity.

END OF SECTION

SECTION 31 23 01

EXCAVATION AND FILL FOR SITE WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Site Excavation, Filling and Backfilling.

B. Precast Utility Structure Excavation, Filling, and Backfilling.

C. Compaction of Fill and Backfill.

D. Finish Grading.

1.02 RELATED WORK

A. Section 31 23 33 – Trenching and Backfilling

1.03 REFERENCES

A. ASTM C33 – Standard Specification for Concrete Aggregates.

B. ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3).

D. ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
   1. Laboratory Test Results for Select Fill, Ordinary Fill, and Pea Gravel:
      a. Moisture-density relationships (ASTM D1557).
      b. Gradation (ASTM C136).
      c. Liquid limit, plastic limit, plasticity index (ASTM D4318).

1.05 PROTECTION

A. Protect trees, shrubs, lawns, and other features remaining as a portion of final site.

B. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from equipment and vehicular traffic.

C. Protect above and below grade utilities which are to remain.

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

E. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.

F. Grade excavation top perimeter to prevent surface water run-off into excavation.

G. Protect structure walls, foundation, and similar features from structural stress during backfilling operations.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Material removed from excavations may be used for fill or backfill provided such material meets the requirements for fill and backfill specified in this Section. Some blending of materials may be necessary.

B. Exclude debris, large rocks, roots, organic material, expansive material and other deleterious materials.

C. Provide additional fill materials if necessary from off-site locations obtained by Contractor.

D. Do not use any materials containing any contaminants that may endanger public health. Do not use mine tailings.

E. Do not use any materials which have not been reviewed by the Engineer.

2.02 MATERIALS

A. Select Fill:
1. Clean, well graded, relatively cohesionless material free of organic or frozen matter.
2. Largest rock or clod dimension, 1".
3. Plasticity index less than 8.
4. Maximum percent passing sieve (unless otherwise reviewed by Engineer):
    a. #10, 50%.
    b. #40, 30%.
    c. #200, 15%.

B. Ordinary Fill:
1. Clean, free of organic or frozen matter.
2. Largest rock or clod dimension, 3".
3. Normally acceptable are Unified Soil Classification System Classified Materials: GW, GP, SW, SP, GM, SM, or GC.

C. Normal Backfill:
1. Excavated earth or sand thoroughly mixed to create uniform material.
2. Free of trash, debris, organic or frozen matter.
3. Largest rock or clod dimension, 2".

D. Pea Gravel:
   1. Mineral aggregate graded 0.25” to 0.38”.
   2. Free of soil, clay and shale; free of organic, frozen debris, or foreign matter.

E. Sandfill:
   1. Clean, well-graded material conforming to requirements of ASTM C33 for fine aggregate.

F. Moisture Barrier: 10 mil minimum polyethylene sheet.

PART 3 EXECUTION

3.01 GENERAL

A. The type of bearing material and the thickness and extent of structural fill (if required) are shown on the Drawings.

B. Interior non-structural slabs-on-grade are to be supported on granular fill not less than 6” thick on select fill not less than one foot thick. See Drawings for location where sand fill over polyethylene moisture barrier is required over granular fill.

C. Do not place or compact fill or backfill when the atmospheric temperatures are below 35 degrees Fahrenheit. Protect completed fill or backfill areas from freezing. Recondition, reshape and recompact to the requirements of this section without additional cost to the Owner any areas which are damaged by freezing.

3.02 SHEETING, SHORING AND BRACING

A. Provide sheeting, shoring and bracing where required to hold walls of excavation and to protect workers and existing construction. Contractor shall be responsible for proper sizing and placement of Work.

B. Remove sheeting, shoring and bracing in manner to avoid damage to disturbance to Work. Leave sheeting and shoring in place where removal will endanger Work, adjacent construction or personnel. If sheeting or shoring is to be left in place, remove all traces of sheeting or shoring to a minimum depth of 2’-0” below finish grade unless otherwise reviewed by the Engineer.

3.03 CLEARING AND GRUBBING

A. General: Clearing and grubbing are required for all areas shown on the plans to be excavated or where fill is to be constructed.

B. Clearing:
   1. Remove and dispose of trees and other vegetation, downed timber, snags, brush, and rubbish within areas to be cleared.

C. Grubbing:
   1. Remove stumps, matted roots, and roots larger than 2” in diameter from within 6” of the surface of areas on which fills are to be constructed, and within 18” of finished subgrade of roadways.

2. Areas disturbed by grubbing shall be filled as specified in this Section for embankment.

3.04 PREPARATION

A. Excavation:
1. Identify required lines, levels, contours, and datum.
2. Identify all underground utilities and other facilities. Stake and flag locations.
3. Identify and flag surface and aerial utilities.
4. Maintain and protect existing utilities remaining which pass through work area.

B. Backfilling:
1. When necessary, compact subgrade surfaces to density requirements for backfill material.
2. Cut out soft areas of subgrade not readily capable of in situ compaction. Backfill with select fill and compact to density equal to requirements for subsequent backfill material.

3.05 EXCAVATION

A. Earth excavation shall consist of the excavation and removal of suitable soils for use as embankment as well as the satisfactory disposal of all vegetation, debris, and deleterious materials encountered within the area to be graded and/or in a barrow area.

B. Excavate soil to the extent required for structure foundations, construction operations, and other work. See Drawings for extent of excavation required beneath and adjacent to structures.

C. Barricade open excavations, keep spoil piles out of the way of the Owner's personnel and otherwise maintain safe access by the Owner's employees to the Owner's facilities during construction.

D. Do not undercut existing construction.

E. Do not permit surface water to enter open excavations. Provide barriers and positive drainage away from excavations as necessary. Remove promptly any water which may enter excavations from any source.

F. Machine slope banks.

G. After excavations are complete, notify Engineer for inspection of completed excavation. Do not begin placement of fill or begin other construction operations until excavation is reviewed by Engineer.

H. Fill unauthorized over excavated areas beneath structures with select fill and compact to density required for subsequent fill or backfill. If unauthorized excavation will result in structure being supported partly on select fill and partly on native material, extend excavation under entire structure and fill as specified below. Fill unauthorized

overexcavated areas away from structures with fill of the type specified for subsequent fill compacted to the density specified.

I. Dispose of all excess excavated material and material unsuitable for backfilling generated by construction activities, off-site or as directed by Owner, unless otherwise stated in Contract Documents at no additional cost to Owner. Properly dispose of all materials in accordance with regulatory requirements.

3.06 SUBGRADE TREATMENT

A. At areas to receive structural fill, scarify the exposed native soils to a depth of not less than 12". Add or remove water as necessary to bring the scarified material to optimum moisture content (within -0, +2 percentage points). Compact the scarified soil to not less than 95% of maximum dry density as determined by ASTM D1557.

3.07 FILLING AND BACKFILLING

A. Provide all fill material required to complete Work, either from on-site excavations or imported from off-site, at no additional cost to Owner.

B. Backfill areas to contours and elevations shown on Drawings using unfrozen materials.

C. Place fill under structures and elsewhere as shown on the Drawings. Fill all unauthorized or excess excavations to the elevations shown or specified.

D. Backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet or spongy subgrade surfaces.

E. Backfilling Around Structures:
1. Backfill after concrete has attained sufficient strength to withstand backfill pressures without detrimental effects.
2. Prevent displacement of construction during backfilling operations; backfill opposite sides simultaneously.

F. Placement:
1. Maintain surfaces free of water, debris, and other deleterious materials.
2. Place backfill and fill materials in successive horizontal layers not more than 8" in loose depth.
3. Place material at optimum moisture content (± 2 percentage points).
4. Material too dry or too wet shall be moistened or aerated to extent necessary to bring moisture content to within specified limits.

G. Compaction:
1. Compact fill and backfill using appropriate equipment as needed to achieve the densities specified below. Densities are expressed as percentages of the maximum dry density as determined by ASTM D1557.
2. Do not use heavy equipment in areas where existing construction may be damaged by the use of such equipment. Repair or replace without additional

cost to the Owner, any damage to existing construction caused by earthwork operations.

H. Slope grade away from building minimum 2" in 10' unless noted otherwise. Fill depressions and provide for positive drainage away from buildings and structures.

I. Make changes in grade gradual. Blend slopes into level areas. Finish grade to smooth uniformly sloping surfaces to elevations required for drainage.

J. Finish surface by grading to provide finished appearance.

K. Place polyethylene moisture barrier at locations shown on the Drawings. Overlap not less than 6" at all joints; tape joints securely. Protect from damage during placement of sand fill. Repair any rips or tears. Place not less than 3" of sand fill over polyethylene moisture barrier beneath slabs-on-grade where shown on Drawings.

3.08 TOLERANCES

A. Top Surface of Backfill: ± 2".

B. Top Surface of Fill Beneath Structures: Minus 1 plus 0 inches.

3.09 FIELD QUALITY CONTROL

A. Section 01 45 23 – Testing Laboratory Services.

B. Test Schedule:
1. One field density test for each 250 square yards of prepared subgrade.
2. One field density test for each 100 cubic yards of fill or for each layer of fill, whichever results in the greater number of tests.
3. Or where directed by Engineer.

C. If tests indicate that work does not meet specified requirements, remove work, replace and retest at no cost to Owner.

3.10 SCHEDULE OF FILL AND BACKFILL

Area	Type of Material	Degree of Compaction
Beneath footings and slabs more than 10” thick and for a distance outside their perimeters equal to the depth of fill	Select fill	95%
Beneath slabs less than 10” thick; pavements (except roadways) unless otherwise shown on Drawings	Select fill	90%
General fills and embankments on the site	Ordinary fill	90%
Non-structural areas except as otherwise shown on Drawings or directed by the Engineer	Ordinary fill	85%
Backfill behind walls and below or adjacent to additional construction	Select fill	95%
Backfill behind retaining walls	Ordinary fill	90%
Backfill except as described above	Normal backfill	90%
Where indicated on Drawings	Select fill	95%
Fill within treatment structures, fill beneath interior slabs on grade over moisture barrier	Sand fill	95%

END OF SECTION

SECTION 31 23 13

SUBGRADE PREPARATION

PART 1 GENERAL

1.01 WORK INCLUDED

A. Preparing the completed subgrade prior to placement of subsequent pavement section components to the grade and dimensions indicated on the Drawings. This is inclusive of all processing, shaping, compacting, watering, protecting and any removal and replacement of unsuitable material to prepare the subgrade satisfactorily for completion of the pavement section.

1.02 REFERENCES

A. American Society for Testing and Materials International:
   1. ASTM D1556 – Density of Soil in Place by the Sand-Cone Method
   2. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
   3. ASTM D2167 – Density of Soil in Place by the Rubber-Balloon Method
   4. ASTM D2216 – Laboratory Determination of Moisture Content of Soil
   5. ASTM D6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.03 QUALITY ASSURANCE

A. Testing Laboratory:
   1. Contractor shall provide material testing for quality control during subgrade preparation.

PART 2 PRODUCTS

2.01 SUITABLE MATERIALS

A. Suitable materials shall consist of materials obtained on site reviewed by the Engineer for the purpose of subgrade preparation.

B. Any underlying soft or otherwise unsuitable material shall be removed and replaced with suitable material.

C. Provide free of vegetation.

2.02 WASTE

A. Disposal of excavated materials shall be the responsibility of the Contractor. Excess material to be placed in location designated by Owner or Engineer.

PART 3 EXECUTION

3.01 PREPARATION

A. Excavations and embankments for the roads and site grading shall be finished to the shapes, dimensions, and elevations shown on the Drawings.

B. Perform clearing operations prior to beginning excavation, grading, and embankment operations.

C. Processed, watered, and compacted to not less than 90% of modified Proctor density (ASTM D1557) at optimum moisture content ±2%, to a depth of 12" minimum.

D. Material that cannot be processed satisfactorily to meet these specifications shall be considered unsuitable.

3.02 GRADING

A. Provide uniform slopes and rounded changes in slope, free of low spots.

B. The degree of grade control shall not deviate from true grade and profile more than one-half inch as measured by a ten-foot straight edge.

C. Drainage:
1. Provide and maintain positive surface water drainage around and away from open excavations.
2. Keep opened excavations dry.
3. Remove free water in excavation promptly.

3.03 FIELD QUALITY CONTROL

A. Sample and Test:
1. At intervals not to exceed 200 feet.
2. At locations designated by the Engineer.

END OF SECTION

SECTION 31 23 18

ROCK EXCAVATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section includes requirements for rock excavation in trenches, pits and open excavations.

1.02 CLASSIFICATION OF ROCK EXCAVATION

A. Excavation to required subgrade elevations or trench dimensions will be classified as either "rock excavation" or "unclassified excavation."

1. **Rock Excavation** includes all materials which, in the opinion of the Engineer, require barring, wedging and/or special impact tools such as hydraulic rock hammers, jack hammers, sledges, chisels, or similar devices specifically designed for use in cutting or breaking rock for removal from their original beds and which have compressive strengths in their natural undisturbed state in excess of 300 psi. Boulders or masonry larger than one cubic yard in volume are classed as rock excavation.
2. **Rock Excavation Field Tests:** Rock excavation is material that meets any one of the following field test criteria:
   a. Ripping Test: Material that cannot be broken down by one pass with a single tooth ripper mounted on a crawler-type tractor in low gear with a minimum net flywheel power rating of 255 hp.
   b. Seismic Test: Material that has a seismic velocity greater than 6,000 feet/second. Submit the qualifications of the person performing and interpreting the seismic testing for Engineer approval at least 14 days before testing. Perform the Ripping Test to resolve differences in material classification if seismic velocities fall below 6,000 feet/second.
   c. Handling Test: Rock with a volume greater than 1 cubic yard that cannot be readily broken down with excavation equipment.
3. **Unclassified Excavation** includes excavation of pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; together with soil and other materials encountered that are not classified as rock or unauthorized excavation. Unclassified Excavation includes excavation done with intermittent drilling or ripping performed solely to increase production, but not necessary to permit excavation of material encountered.

1.03 RELATED WORK

A. Section 01 29 00 – Payment Procedures

1.04 VERIFICATION

A. If verification is required, Contractor shall employ a Geotechnical Firm to perform rock excavation field tests and verify quantity and depth of rock excavation at no additional cost the Owner. These field tests are not part of material testing specified under Section 01 45 23 – Testing Laboratory Services.

B. The quantity of detached rocks and boulders shall be measured before they are incorporated into earth haul. Rock material that is not measured and is incorporated into the earth haul will be considered Unclassified Excavation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SITE CONDITIONS

A. Classification and Quantity: Make investigations and determinations necessary to determine the classification and quantities of rock excavation and the methods to be used to excavate these materials.

B. Determination of Classification: If difficult excavation conditions are encountered within defined limits, they will be classified as "Rock Excavation" if mutually agreed upon by the Contractor's superintendent and the Owner's Resident Project Representative at the time the condition is encountered, and the Contractor will be paid at the rock excavation unit bid price. If the Contractor's superintendent and the Owner's Resident Project Representative do not mutually agree on the classification, the Contractor shall demonstrate to the Engineer's satisfaction that the areas in question meet one of the Rock Excavation Field Tests as specified herein.

3.02 BLASTING

A. Blasting of rock is not permitted.

3.03 ROCK EXCAVATION – MECHANICAL METHOD

A. Excavate rock using mechanical methods.
   1. Cut away rock at bottom of excavations to form level bearing that follows natural strata. Form with sharp steps.
   2. Remove final layers carefully to provide sound and unshattered base for footings and foundations as needed.
   3. Remove boulders and fragments that may slide or roll into excavated areas.

PART 4 PAYMENT

4.01 MEASUREMENT

A. Unit of Measurement for Rock Excavation in Trenches: Linear foot of trench, or as specified otherwise in the Bid Form.

B. Unit of Measurement for Rock in Open Excavations: Cubic yard, or as specified otherwise in the Bid Form.

4.02 PAYMENT ITEMS

A. Payment for ROCK REMOVAL and DISPOSAL will be at the Contract unit price for Rock Excavation. The unit price will be full compensation for labor, material, equipment, and work required for verification, drilling, excavation, loading, dumping, and spreading rock material; forming embankments; shaping and trimming slopes and surfaces; and replacing with specified fill.

END OF SECTION

SECTION 31 23 23.33

FLOWABLE FILL BACKFILL

PART 1 GENERAL

1.01 WORK INCLUDED

A. Trench Backfilling.

B. Bedding of Buried Pipes.

1.02 REFERENCES

A. American Society for Testing and Materials International (ASTM):
1. ASTM C31 – Making and Curing Concrete Test Specimens in the Field.
2. ASTM C94 – Ready-Mixed Concrete.
3. ASTM C138 – Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
4. ASTM C143 – Slump of Hydraulic-Cement Concrete.
5. ASTM C150 – Portland Cement.
6. ASTM C172 – Sampling Freshly Mixed Concrete.
7. ASTM C192 – Making and Curing Concrete Test Specimens in the Laboratory.
8. ASTM C231 – Air Content of Freshly Mixed Concrete by the Pressure Method.
9. ASTM C260 – Air-Entraining Admixtures for Concrete.
10. ASTM C558 – Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.
11. ASTM C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
12. ASTM C685 – Concrete Made by Volumetric Batching and Continuous Mixing.
13. ASTM D1633 – Compressive Strength of Molded Soil-Cement Cylinders.

1.03 SUBMITTALS

A. Product data for cement and admixtures.

B. Flowable fill mix design.

C. Testing laboratory results on mix design to demonstrate compliance with Specifications.

D. Field testing results at time of placement.

E. Field testing for acceptability 24 hours after placement.

F. Compression test results.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bedding Materials: Refer to Section 31 23 33 – Trenching and Backfilling.

B. Backfill Material – Flowable Fill:
1. Backfill materials are those materials placed in the trench between the bedding material and the top of the trench or compacted soil backfill.

2.02 CONCRETE MIX – BACKFILL MATERIAL (FLOWABLE FILL FOR FILLING VOIDS IN COMPLIANCE WITH 2019 NMDOT STANDARD SPECIFICATION SECTION 516.)

A. General: Flowable fill is a flowable mixture of Portland cement, fly ash, aggregates, admixtures, and water.

B. Cement: Comply with ASTM C94, and ASTM C150, Portland Type I-II, low alkali.

C. Fly Ash: Class F, Class C, or Class C/F blended fly ash in accordance with ASTM C618.

D. Cementitious Material Content:
1. Cement: 50 pounds/cubic yard maximum.
2. Fly Ash: 150 to 300 pounds/cubic yard.

E. Compressive Strength:
1. Compressive strength requirement shall be fully achieved in time indicated.
2. Compressive Strength at 28 Days: 150 psi maximum when sampled and tested as specified in Part 3.
3. Concrete that does not meet the specified strength in the specified time is not acceptable regardless of what strength it may later demonstrate, and at the Engineer's sole discretion:
   a. Shall be removed and replaced at the Contractor's sole expense, or
   b. May be allowed to remain as part of the project, but the Contractor will not be paid for the total in-place cost of the concrete.

F. Slump: 8 to 11 inches. Water / Cement Ratio: Proportioned by weight to produce a slump within the prescribed limits.

G. Admixtures:
1. Batching method and time of introduction shall be in accordance with the manufacturer's recommendations for compliance with this Specification.
2. Use of a water reducing admixture is optional.
3. Calcium chloride shall not be used.
4. Air Entraining Admixture: ASTM C260, optional, 35% air maximum.

H. Combined Aggregate Gradation (Consistent aggregate throughout the concrete mixture):

SCREEN SIZE	% PASSING
1 inch	100
3/8 inch	95-100
No. 4	80-100
No. 8	60-95
No. 16	45-80
No. 30	25-60
No. 50	5-45
No. 100	5-35
No. 200	0-30

PART 3 EXECUTION

3.01 INSPECTION

A. Refer to Section 31 23 33 – Trenching and Backfilling

3.02 BATCHING, MIXING AND DELIVERY

A. Ready-Mixed Concrete: ASTM C94.

B. Field Batched Concrete: ASTM C685.

C. Delivery Ticket: Deliver to Owner's Field Representative prior to unloading at site.
1. Name of flowable fill supplier.
2. Delivery ticket number.
3. Date of delivery.
4. Name of Contractor.
5. Name or location of project.
6. Design mix number.
7. Volume of flowable fill in load.
8. Time loaded.
9. Batched weight of cement, fly ash, fine aggregate, coarse aggregate.
10. Batched weight or volume of admixtures and water.
11. Reading of mixer drum revolution counter at start of mixing.
12. Certification that materials delivered are same brand, type and source as those defined in the design mix authorized by the Engineer.
13. Target proportions of the design mix.
14. Weight or volume of water added at the job site.
15. Signature and name of person who authorized addition of water after leaving the batch plant, and affiliation to the project.

3.03 PLACING

A. Before placing flowable fill, remove all loose or uncompacted soils from area to be filled. Place flowable fill against compacted surfaces only.

B. Secure utility pipe from movement and flotation.

C. Place flowable fill uniformly without voids or segregation.

D. Place flowable fill in lifts not exceeding 12 feet in height. Do not place in lifts more than 4 feet in height for areas that require forming. Do not place over previous lift until previous lift has been placed for at least 2 hours.

E. Do not place flowable fill on frozen material, in standing water, or during rain. Protect flowable fill from flooding or disturbance for at least 24 hours after placement.

F. If necessary, flowable fill may be placed in standing water that is positioned to keep the outside water from contaminating or mixing with the flowable fill.

G. Place flowable fill only when ambient temperature is at least 35°F and rising. If ambient temperature at the time of placement is less than 40°F, the temperature of the flowable fill placed shall not be less than 50°F.

3.04 FIELD TESTING ACCEPTABILITY OF FLOWABLE FILL AFTER 24 HOURS

A. For field testing, the Contractor shall use a standard (15 lb.) T-post fence driver to drive a #6 reinforcing bar with a flat end into the flowable fill material 24 hours after placement. The Contractor shall lift the driver until the bottom of the driver is even with a mark located 6 inches below the top of the rebar, and then allow it to fall under its own weight.

B. The Contractor shall remove and replace the flowable fill if fewer than six (6) blows or more than 25 blows are required to drive the rebar 12 inches into the fill.

C. The Contractor shall not used compressive strength test cylinders for field-testing purposes.

3.05 APPLICATION OF LOAD

A. Do not place any load on or disturb the flowable fill until it exceeds a penetration resistance of 12 psi.
   1. Penetration resistance will be considered acceptable if a person weighing at least 150 pounds, by using his body weight as an axial load on a 3-1/2 inch x 3-1/2 inch wooden block, cannot penetrate the material more than 1 inch.

3.06 FIELD QUALITY CONTROL

A. Field quality control is required to ensure compliance with the project requirements. All portions of the field quality control sampling and testing shall be performed by the testing laboratory selected by the Contractor and accepted by the Engineer.

B. Field quality control testing shall include but not be limited to the following:
   1. Sampling: ASTM C172.
   2. Test Sample:
      a. Frequency: One for each 150 CY or each day's placement, whichever is greater.
      b. Field Tests:
         1) Slump: ASTM C143.
         2) Air Content: ASTM C231.
         3) Unit Weight: ASTM C138.
         4) Temperature.
      c. Compression Tests:
         1) Sample: Do not use material from the field tests.
         2) Molds: 4-inch diameter x 8-inch high, perforated on bottom with four 1/4-inch diameter holes for free-draining, ASTM D 558.
         3) Initial Field Curing: 24 ± 4 hours in mold, ASTM C31.
         4) Laboratory Curing: After initial curing, extrude from mold and cure in laboratory per ASTM C192, do not cure in curing tank.
         5) Number of Specimens: Six; test two at 7 days, two at 28 days, and two at 56 days.
         6) Compression Testing: ASTM D1633.
   3. Reporting:
      a. Written report to Engineer within 4 days of completion of a test.
      b. Non-complying Test Results: Notify Engineer within 1 working day after completion of a test.

3.07 SCHEDULE

A. Backfill with flowable fill where indicated on Drawings.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Trenching, Backfilling, and Compacting for Buried Pipes and Manholes

B. Bedding of Buried Pipes

C. Pipe Marking Systems

1.02 REFERENCES

A. ASTM C12 – Installing Vitrified Clay Pipe Lines

B. ASTM D256A – Determining the Izod Pendulum Impact Resistance of Plastics, Method A

C. ASTM D638 – Tensile Properties of Plastic

D. ASTM D695 – Compressive Properties of Rigid Plastics

E. ASTM D790 – Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

F. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)

G. ASTM D1593 – Non-Rigid Vinyl Chloride Plastic Film and Sheeting

H. ASTM D2321 – Underground Installation of Flexible Thermoplastic Sewer Pipe

I. ASTM D2583 – Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

J. ASTM D2774 – Underground Installation of Thermoplastic Pressure Piping

K. ANSI/AWWA C150/A21.50 – Thickness Design of Ductile-Iron Pipe

L. ANSI/AWWA C151/A21.51 – Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

M. ANSI/AWWA C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances

N. ANSI/AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fitting for Water

O. OSHA Regulations, 29 CFR 1926 Subpart P – Excavations

1.03 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Testing laboratory results on bedding materials to demonstrate compliance with Specifications.
2. Product data for identification tape, marker posts, tracer wire system, and electronic marker device system, if scheduled.

1.04 JOB CONDITIONS

A. All trenching is unclassified.

B. Protect adjacent structures and surrounding areas.

C. Work to remain within available easements.

D. Weather:
1. No backfill placement during freezing weather.
2. No frozen materials, ice, or snow in backfill or fill.
3. No backfill or fill on frozen surfaces.

1.05 REGULATORY REQUIREMENTS

A. Comply with OSHA Standard 29 CFR Part 1926, Subpart P – Excavations, during all excavation, trenching, and shoring operations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bedding Materials:
1. Bedding materials are those materials located a maximum of 8” below bottom of pipe to bottom or spring line of pipe, depending on bedding class or condition required.
2. Material shall be granular and free flowing:
a. Maximum particle or clump size:
1) Plastic Pipe 8” Diameter and Smaller: 0.25”.
2) All other Pipe: 0.75”.
b. Portion Passing No. 200 Sieve: 50% maximum.
c. Free from refuse, organic material and frozen soils.
3. Materials require prior written approval.
4. Concrete: Division 03.

B. Initial Backfill Materials:
1. Initial backfill material is that material placed above the bedding material, around and over the pipe to 12” over the top of the pipe.
2. Material to be defined and required by applicable ASTM standard for installation for bedding class or type required or scheduled.

3. In no case shall initial backfill material contain particles or clumps with any dimension greater than:
    a. Plastic Pipe 8” Diameter and Smaller: 0.25”.
    b. All Other Pipe: 0.75”.
4. If not otherwise defined, same as bedding material.

C. Backfill Materials:
1. Backfill materials are those materials placed in the trench between the initial backfill material and the top of the trench.
2. Material to be as defined and required by applicable ASTM standard for installation for bedding class or type required or scheduled.
3. Backfill shall have no particles or clumps having a dimension larger than 6” within 3’ of the top of the pipe.

D. Materials Not Allowed:
1. All pipe bedding, initial backfill, and backfill material shall be clean and free of roots, vegetable or organic material, frozen material, mine tailings, or any contaminants that could endanger public health.

E. Identification Tape:
1. Identification tape shall consist of high visibility, color coded inert polyethylene tape that is impervious to all known alkalis, acids, chemical reagents and solvents found in the soil.
2. The tape shall have the following properties:
    a. Minimum overall thickness: ASTM D1593: Plain, 4.0 mils; detectable, 4.5 mils.
    b. Minimum tensile strength (longitudinal): ASTM D638: Plain, 1500 psi; detectable, 4,544 psi.
    c. Maximum imprint length: 36”.
    d. Width: 3” for plain tape without metallic foil stripes.
    e. Detectable Tape Metallic Foil Stripes: Permanently laminated to the polyethylene tape so that tape may be more readily located using a metal detector. Refer to Part 3 for application of use. Width: 6 inches.
3. Tape to meet the APWA Uniform Color Code for utilities.
4. Imprinted message, “Caution Buried Utility Line Below”, printed with black letters on APWA approved colors.
5. Acceptable Manufacturers:
    a. Seton Identification Products, Branford, CT or Engineer reviewed equivalent.

F. Tracer Wire System:
1. Provide tracer wire system as shown on the Drawings and as specified herein.
2. Install single run of tracer wire on top of pipe.
3. Secure wire to pipe every 10’ with pipe wrap tape (tape required to hold wire in place during backfill).
4. Bring wire to surface at every valve box, vault, hydrant, manhole, every 1,000 linear feet, and where shown on Drawings.
5. Terminate wire at surface using a tracer terminal box.

6. All tracer system components such as terminal box cover, wire insulation, and connectors shall be in accordance with APWA Uniform Color Code for utilities.
7. Tracer Wire: #12 AWG, UL listed, 30V single conductor, tracer wire, with 30 mil high density polyethylene (HDPE) insulation.
    a. Copper-clad annealed high carbon 1055 Grade steel wire, break load 452 lbs. steel core shall be manufactured in the United States. Copperhead Industries LLC, High Strength HS-CCS, or Engineer reviewed equivalent.
    b. Solid strand copper, Agave Wire LTD, Paige Tracer, or Engineer reviewed equivalent.
    c. If tracer wire is scheduled to be used on utilities installed by horizontal directional drilling, refer to Section 33 05 23.13 – Utility Horizontal Directional Drilling.
8. Pipe Wrap Tape:
    a. Material: 10 mil all weather polyvinyl film.
    b. Durability: Resistant to moisture and corrosive soil.
    c. Adhesion: Adheres to metal and plastic, and conforms to irregularities in substrate surface.
    d. Elongation: 245%.
    e. Tensile Strength: 30 psi.
    f. Width: 2".
    g. Printed Identification Marking: UPC code, and mil thickness.
    h. Acceptable Manufacturer: Northtown Company, or Engineer reviewed equivalent.
9. Tracer Terminal Box:
    a. Copperhead Industries, LLC, Snake Pit Magnetized Tracer Boxes, or Engineer reviewed equivalent.
        1) Light Duty Box: Locate next to structures and not subject to direct damage (such as adjacent to a fire hydrant).
        2) Roadway Box: Locate in or adjacent to road and subject to road traffic.
        3) Concrete / Driveway Box: Locate in areas of concrete pavement.
10. Corrosion-Resistant Wire Connectors:
    a. Direct bury twist-on wire nuts, prefilled with dielectric silicone. For use when connecting between spools (2 conductors max.). Copperhead Industries, LLC, Agave Wire LTD, or Engineer reviewed equivalent.
    b. Direct bury lugs, prefilled with dielectric silicone. For use when connecting to terminal electrical box. Copperhead Industries, LLC, Agave Wire LTD, or Engineer reviewed equivalent.
    c. Acceptable for use in place of wire nuts and/or lugs, Copperhead Industries, LLC, twist locking, watertight connectors, with dielectric silicone, or Engineer reviewed equivalent.
11. Test for electrical continuity after installation in accordance with manufacturer's recommendations using manufacturer's cable tracing equipment. Provide test reports to Engineer for review.

G. Underground Cable Tracing Equipment:
   1. Receiver Details:
      a. Active Frequencies (Hz): 491, 982, 8.44k, 9.82k, 35k, 82k, 83k (North America).
      b. Passive Frequencies (Hz): 50, 60, 100, 120, RF (14k-21k).
      c. Extended and special frequency sets available.
      d. Depth Display Accuracy: 0'-10': ±(5%+2") under ideal field conditions
      e. 10'-20': ±10% under ideal field conditions.
      f. Depth Range: Maximum 20' (600 cm).
      g. Gain adjustment automatic & manual with pushbutton centering.
      h. Controls: Four-way navigation key and soft keys.
      i. Display Indicators: Frequency audio volume, battery condition, guidance compass, distortion, alert, signal select, signal strength, distance sensitive left / right.
      j. Guidance, menu softkey, frequency softkey.
      k. Line ID: Signal select, guidance compass, distortion alert.
      l. Display: 1/4 VGA bright color.
      m. Antenna: Distance sensitive left / right guidance.
      n. Data Acquisition: Internal data logging memory.
      o. Operating Temperature: -4°F to +122°F (-20°C to +50°C).
      p. Battery Type: Rechargeable battery pack for transmitter.
      q. Battery Life: 30 hours continuous.
      r. Battery Check: Continuous display.
      s. Regulatory Compliance: FCC, CE.
      t. Environmental: IP54.
   2. Transmitter:
      a. Output Frequencies (Hz): 491, 982, 8.44k, 9.82k, 35k, 82k, 83k.
      b. Extended and special frequency sets available.
      c. Output Power: Variable to 10W.
      d. Simultaneous Output: Up to three active frequencies.
      e. Controls: Frequency select, measurement units (mA, Volts, Ohms, Watts), output power, signal select, menu, 4-way navigation, select, SFL, on / off.
      f. Display Indicators: Battery status, audio volume, output mode, frequency setting, frequency output, % output in SFL or induction mode, output graph, loop resistance graph.
      g. Display: 1/8 VGA monochrome.
      h. Battery Type: Rechargeable battery pack for transmitter.
      i. Battery Life: 6-12 hours continuous use, depending on power level and line conditions.
      j. Operation Temperature: -4ºF to +122º F (-20ºC to +50º C).
      k. Regulatory Compliance: FCC, CE.
      l. Environmental: IP54.
   3. Included Accessories: Receiver, transmitter, connection cables, ground stake, ground cable, carrying case, rechargeable battery pack for transmitter, and ground fault locating kit.
   4. Manufacturer: Amprobe® AT-5005 Professional or Engineer reviewed equivalent.

H. Utility Marker Posts:
1. Description: Flexible, single piece marker having flat cross-section with three reinforcing ribs and pointed end.
2. Material: Composite flexible glass fiber-reinforced polymer with UV-resistant outer shell, serviceable from -40°F to 140°F.
3. Physical Properties:
   a. Tensile Strength, ASTM D638: 30,000 psi min.
   b. Tensile Elongation, ASTM D638: 2% min., 10% max.
   c. Compressive Strength, ASTM D695: 30,000 psi min.
   d. Notched Izod Impact Strength, ASTM D256A: 50 ft.-lb./in. min.
   e. Barcol Hardness, ASTM D2583: 50 min.
   f. Flexural Strength, ASTM D790: 30,000 psi min.
   g. Flexural Modulus, ASTM D790: 1,000,000 psi min.
4. Dimensions: 3.75" wide x 5'-2" long.
5. Color: Standard APWA color code, integral pigment.
6. Decal: Standard, non-reflective message for utility to be identified, standard APWA background color, UV-resistant, factory installed.
7. Accessories: Flexible anchor barb, factory installed.
8. Acceptable Manufacturers: Carsonite Division of Ametek, Inc. or Engineer reviewed equivalent.
9. Refer to Part 3 for application of use.

I. Electronic Marker Device (EMD):
1. Type: Passive inductive device capable of reflecting a specifically designated industry standard impulse frequency, unique to the utility being installed.
2. Color Code: EMDs shall be color coded in accordance with American Public Works Association uniform color code for marking utilities.
3. Industry Standard impulse frequencies:

Utility	Color	Frequency
Power	Red	169.8 kHz
Potable Water	Blue	145.7 kHz
Sanitary, Sludge	Green	121.6 kHz
Telephone	Orange	101.4 kHz
Gas	Yellow	83.0 kHz
Non-Potable Water	Purple	66.35 kHz

4. Construction: Water-resistant high density polyethylene case.
5. Range: 5'.
6. Installation: Install EMDs in trench above utility line in accordance with manufacturer's instructions.
7. Locations: Install EMDs over new buried utility lines at the following locations:
   a. At all horizontal bends 22.5° and larger.
   b. At all tees and wyes.
   c. At all capped or plugged ends.

PART 3 EXECUTION

3.01 INSPECTION

A. Field verify location of underground utilities and obstructions.

3.02 CLEARING AND GRUBBING

A. General: Clear and grub all areas within the construction limits that will be disturbed by trenching or stockpiling.

B. Clearing: Remove and dispose of trees and other vegetation, downed timber, snags, brush, and rubbish within areas to be cleared.

C. Grubbing: Remove stumps, matted roots, and roots larger than 2” in diameter from areas to be excavated and from within 6” of surface of areas to receive stockpiled material. Do not allow grubbed material to mix with trench backfill.

D. Disposal:
1. Haul and dispose of all debris, rubbish, vegetation, broken concrete, broken asphaltic concrete, rocks, and other material to be removed.
2. Properly dispose of material in accordance with applicable state and federal regulations.
3. Burning of debris and rubbish will not be permitted on the project site.

3.03 DEWATERING

A. Provide and maintain adequate dewatering equipment to remove and dispose of surface and groundwater entering excavations, trenches, and other parts of the Work.

B. Keep excavation dry during subgrade preparation and continuously thereafter until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation or other cause will result.

C. Dewater excavations which extend to or below groundwater by lowering and keeping the groundwater level beneath such excavation at least 12” below the bottom of the excavation.

D. Divert surface water or otherwise prevent it from entering excavated areas or trenches to the extent practical without damaging adjacent property.

E. Contractor is responsible for the condition of any pipe or conduit he uses for drainage; all drainage pipes, ditches, etc. shall be left clean and free of sediment.

3.04 BLASTING

A. Blasting is not allowed.

3.05 SHEETING

A. If used, cut off at top of pipe and leave in place unless removal is specifically reviewed by Engineer.

3.06 STABILIZATION

A. Thoroughly compact and consolidate trench bottoms so they remain firm, dense, and intact during required construction activities.

B. Remove all mud and muck during excavation.

C. Reinforce trench bottom with crushed rock or gravel if it becomes mucky during construction activities.

D. Allow no more than 1/2" depth of mud or muck to remain on trench bottoms when pipe bedding material is placed thereon.

E. Where trench bottoms-out in rock, rock is to be removed to 8" below bottom of pipe and replaced with bedding material.

3.07 TRENCH EXCAVATION

A. Slope, bench, or support all trenches in conformance with OSHA Excavation Regulations, and follow all specified safety requirements.

B. Do not open more trench in advance of pipe laying than is necessary to expedite the Work; not more than 400', unless otherwise authorized by Engineer.

C. Except where jacking and boring is indicated on the Drawings, specified or permitted by Engineer, excavate trenches by open cut from the surface.

D. Alignment, Grade, and Minimum Cover:
1. Establish alignment and grade or elevation from offset stakes.
2. Excavate trenches so pipes can be laid straight at uniform grade without dips or bumps, between the terminal elevations indicated on the Drawings.
3. Comply with pipe Specification Sections regarding vertical and horizontal alignment and max joint deflection.
4. Water lines to have minimum bury as shown on the Drawings, and in general, grade shall follow surface contours unless otherwise shown on the Drawings.

E. Limiting Trench Widths:
1. Excavate to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, embedment.
2. If needed to reduce earth loads to prevent sloughing cut banks back on slopes which extend not lower than 1' above the top of the pipe.

3. Trench widths and minimum clearances between installed pipe and trench wall:

Pipe Size	Minimum Trench Width	Minimum Clearance	Maximum Trench Width at Top of Pipe
18" or less	O.D. plus 16"	8"	O.D. plus 24"
Larger than 18"	O.D. plus 24"	12"	O.D. plus 24"

F. Mechanical Excavation:
1. Do not use where its operation would damage trees, buildings, culverts, or other existing property, structures, or utilities above or below ground; hand-excavate only in such areas.
2. Use mechanical equipment of a type, design, and construction and operated so that:
   a. Rough trench bottom elevation can be controlled.
   b. Uniform trench widths and vertical sidewalls are obtained from 1' above the top of the installed pipe to the bottom of the trench.
   c. Trench alignment is such that pipe is accurately laid to specified alignment and is centered in the trench with adequate clearance between pipe and trench sidewalls.
   d. Do not undercut trench sidewalls.

G. Cuts in Existing Paved Surfaces:
1. Applies to streets, sidewalks, curbs, driveways, and other existing paved surfaces.
2. No larger than necessary to provide adequate working space.
3. Cut a clean groove not less than 1-1/2" deep along each side of trench or around perimeter of excavation area.
4. Remove pavement and base pavement to provide shoulder not less than 6" wide between cut edge and top edge of trench.
5. Do not undercut trenches, resulting in bottom trench width greater than top widths.
6. Make pavement cuts to and between straight or accurately marked curved lines parallel to trench centerline or limits of excavation.
7. Where the trench crosses existing paved surfaces, remove and replace the paved surface between saw cuts as specified for pavement.

H. Excavation Below Pipe:
1. Except as otherwise required, excavate trenches below the underside of pipes as indicated on the Drawings to allow placement of granular pipe bedding material.
2. Where excavating in earth for 6" and smaller pipe, Contractor has the following options for excavating trench bottoms:
   a. Excavate below pipe subgrade and place granular embedment.
   b. Grade trench bottom to provide uniform and continuous support between bell holes or end joints.

I. Excavation for Bell Holes:
   1. Excavate to provide adequate clearance for tools and methods of pipe installation.
   2. Do not allow any part of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined.

J. Excavated Material: Place stockpiled excavated materials in a manner that will not obstruct work or endanger personnel or the public.
   1. Excavated materials shall not obstruct sidewalks or driveways for extended periods of time.
   2. Excavated materials shall not obstruct hydrants, valve pit covers, valve boxes, or other utility controls.
   3. Excavated materials shall not obstruct gutters, unless other temporary provisions have been made for street drainage.
   4. Excavated materials shall not obstruct natural drainage ways.

K. Surplus Excavated Material: Excavated material in excess of that needed to backfill to the limits indicated in the Contract Documents shall be properly disposed off-site in compliance with regulatory requirements at no additional cost to the Owner.

3.08 PIPE BEDDING

A. Class D per ASTM C12

B. Class C per ASTM C12

C. Class B per ASTM C12

D. Crushed Stone Encasement per ASTM C12

E. Class A-I: ASTM C12 Class A-1 using plain concrete.

F. Class A-II: ASTM C12 Class A-1 using reinforced concrete; No. 4 A-36 steel reinforcing bars parallel to pipe with steel area not less than 0.4% of the area of concrete above top of pipe.

G. Class A-III: ASTM C12 reinforced concrete encasement; 3000 psi concrete; No. 4 A-36 steel reinforcing bars; reinforcing parallel to pipe with steel area not less than 0.4% of the area of concrete above and below pipe; reinforcing bars wrapped around parallel bars at 36” maximum spacing.

H. Bedding class or type as scheduled.

I. Carefully place bedding in accordance with ASTM C12 to provide uniform and continuous support to pipe barrel, except at bell holes in all cases. No bridging will be allowed.

3.09 MANHOLE SUBGRADE

A. Subgrade Material: Use same bedding class as specified for adjacent pipe bedding.

B. Compaction: 90% ASTM D1557.

3.10 TRENCH BACKFILL

A. Material as defined by applicable reference for installation for type of pipe used.

B. Bedding, Initial Backfill, and Backfill:
1. Suitable Materials: If native materials cannot meet the requirements of Part 2 specified herein or if the specified field compaction cannot be obtained, Contractor shall import suitable material at no additional cost to the Owner.
2. Moisture Content of Placed Materials: Shall be ± 2 percentage points of optimum moisture content determined by ASTM D1557.

C. Bedding: Carefully "shovel-slice" or tamp bedding so that the material fills and supports the haunch area under the pipe without voids.

D. Initial Backfill: Place in layers that do not exceed 8" in height of backfill material in its uncompacted state.

E. Backfill: Place in layers heights suitable to enable the Contractor to achieve the specified compaction throughout the full depth of backfill using Contractor's selected means and methods and without damaging the pipe, but no greater than 18" compacted.

F. Paved Traveled Areas:
1. 90% ASTM D1557 compaction.
2. Top 12″ below subgrade, 95% ASTM D1557 compaction.

G. Unpaved Traveled Areas and Treatment Plant / Pump Station Sites:
1. 90% ASTM D1557 compaction.

H. Untraveled Areas: Compacted to at least undisturbed natural density but not less than 85% ASTM D1557.

I. Water Settled Backfill: Use only where permitted by Engineer:
1. Where permitted, apply to obtain effective settlement with a minimum of water.
2. Do not permit trench to overflow.
3. Do not settle by water puddling until after trench has been backfilled to ground surface.
4. Introduce water above the pipe embedment through a long pipe nozzle so disturbance of granular embedment or compacted material is held to an absolute minimum.
5. Add backfill material to compensate for settlement below surface grade and settled during puddling operations.

J. Install identification tape in backfill 24" directly above top of all buried pipe, unless otherwise scheduled or shown on Drawings. Use tape with metallic foil stripes for all non-metallic pipes.

K. Install Utility Marker Posts as Follows:
1. Install posts in untraveled areas over centerline of pipe at each horizontal bend made with fittings and at 500’ intervals between bends.
2. Install face of posts perpendicular to centerline of pipe and facing the downstream direction.
3. Bury posts 18” deep.

L. Upper 18” of trench shall contain no particles larger than 6” in any dimension.

M. Surface Finish:
1. For placement of paving or gravel surfacing, subgrade where applicable.
2. Match existing and surrounding contours.
3. Graded finished appearance.

3.11 FIELD QUALITY CONTROL

A. Section 01 45 23 – Testing Laboratory Services

B. Section 01 71 23 – Field Engineering

C. Test Schedule unless otherwise directed by the Engineer:
1. Minimum of one field density test for each compacted layer of trench backfill for each 250 linear feet of trench in traveled areas.

D. Minimum of one field density test for each compacted layer of trench backfill for each 500 linear feet of trench in untraveled areas.

E. Minimum of two field density tests for each compacted layer of trench backfill at each road crossing.

3.12 PIPE BEDDING SCHEDULES

A. Cast or Ductile Iron Pipe:
1. Minimum Bedding Class:

Pipe Diameter	Trench Depth To Top of Pipe	Bedding Class
14” or less	5’ or less	D
	5’ – 12’	C
	More than 12’	B
Larger than 14″	12’ or less	C
	More than 12’	B

B. PVC, HDPE, and Other Plastic Type Pipes:
1. As recommended by manufacturer.
2. Minimum Bedding Class:
   a. Trench depth to top of pipe less than 10’; Class C.
   b. Trench depth to top of pipe 10’ or more; Class B.
3. Gravity sewer lines bedded to meet maximum deflection requirements given with pipe Specifications.

C. Concrete:
   1. Minimum Bedding Class: Class B.

D. Unstable Trench Conditions Due to Groundwater:
   1. Crushed stone encasement with the following minimum limits:
      a. 12” below bottom of pipe.
      b. Full width of excavated trench.
      c. 12” above top of pipe.

3.13 PIPE MARKING SCHEDULE

A. Identification Tape: Sanitary Sewer Pipe.

B. Tracer Wire System:
   1. Wire Location: Sanitary Sewer Pipe.
   2. Cable Tracing Equipment: Not Required.
   3. Payment for Tracer Wire in Place: Refer to Section 01 29 00 – Payment Procedures, Paragraph 1.03.A.3.f.

C. Utility Marker Posts: Sanitary Sewer Pipe.

D. Electronic Marker Device (EMD): Sanitary Sewer Pipe.

END OF SECTION

SECTION 32 09 00

REMOVAL AND REPLACEMENT OF EXISTING SURFACES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Removal and replacement of existing asphalt and concrete paving, sidewalks, curb and gutter, and driveways removed incidental to the Work of the contract.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO T 166 – Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens.
   2. AASHTO T 209 – Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt Paving Mixtures.

B. American Society for Testing and Materials International (ASTM):
   1. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3).
   2. ASTM D2950 – Density of Bituminous Concrete in Place by Nuclear Methods.

C. New Mexico State Department of Transportation (NMDOT):
   1. Standard Specifications for Highway and Bridge Construction.

1.03 TESTING AND INSPECTION

A. Representative samples shall be taken from each concrete truck and tested for:
   1. Slump
   2. Air entrainment
   3. Compressive strength (7 day, 14 day, 28 day) (4 cylinders per truck).

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
   1. Product Data.
   2. Gradations and other laboratory results.

B. Design mix for asphalt and concrete

C. Certify that materials comply with Specification requirements.

D. Testing Laboratory Test Results

PART 2 PRODUCTS

2.01 MATERIALS

A. All replacement materials to be new and of same quality or better than existing.

PART 3 EXECUTION

3.01 REMOVAL

A. Asphaltic and Concrete Paving Material:
   1. Sawcut lines, the full depth of the material, straight and parallel without abrupt jogs, vertical to the surface.
   2. Broken out and removed entirely; rubble to be wasted at an approved location.

B. Sidewalks and Curb and Gutter:
   1. Sawcuts at exiting joints only.
   2. Broken out and removed entirely; rubble to be wasted at an approved location.

C. Gravel Surface and Subgrade Material:
   1. Removed entirely.
   2. May be stockpiled and reused for replacement or removed and wasted at an approved location.
   3. Material for reuse must be clean, free of debris, organic and deleterious substances, and used only with the review of the Engineer.

3.02 PREPARATION FOR REPLACEMENT

A. Subgrade materials same thickness and type as removed.

B. Subgrade compaction as shown on the Drawings, not less than 90% modified Proctor, ASTM D1557.

C. Existing gravel materials to be reused to be clean as required.

3.03 REPLACEMENT SCHEDULE

A. Replacement shall be constructed to conform to existing lines, grades, shape, thickness, and finish, unless otherwise scheduled or shown on Drawings.

B. Asphalt pavement to be placed with laydown machine when practical.

C. Mix design for asphalt pavement shall meet New Mexico Department of Transportation Department Standard Specifications for Highway and Bridge Construction Current Edition, Section 423.2.8 – Mix Design, Hot Mix Asphalt (HMA) Superpave SP-IV requirements. Unless indicated otherwise, standard section shall be 4 inches SP-IV on 6 inches compacted base course and 12 inches of subgrade preparation.

D. Quality Control for Asphalt Pavement Compaction:

1. Monitor the compaction process by determining the density of the SP-IV with a portable nuclear density test device in conformity with ASTM D2950. Calibration of the portable nuclear device shall be established from cut pavement samples. The density readings of the cut pavement samples shall be determined in accordance with AASHTO T 166 (weight, volume method) and the density readings of the pavement shall be determined by the portable nuclear density test device in conformity with ASTM D2950 and shall be correlated by the test lab. Conduct three density tests for each 500 sy, or fraction thereof, of each lift each day.
2. The range density for acceptance of SP-IV shall be 95% (±3%) of the theoretical maximum density as determined from AASHTO T 209.

E. Concrete pavement, curb and gutter and gutter and sidewalks shall conform to Division 03, except the minimum 28-day compressive strength shall be 3,000 psi. Unless indicated otherwise, standard section shall match existing thickness (minimum 4 inches on 6 inches compacted base course and 12 inches of subgrade preparation.) Sections for concrete sidewalks do not require base course.

F. Base course mix design shall conform to the New Mexico Department of Transportation, Standard Specifications for Highway and Bridge Construction, current edition-Section 303, Gradation I.

END OF SECTION

SECTION 32 12 01

PAVING, GRAVEL SURFACING, AND RESURFACING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Subgrade preparation.

B. Crushed aggregate base course.

C. Prime coat.

D. Asphaltic concrete surface course.

E. Paving repair and replacement.

F. Repair and replacement of gravel and other surfacing.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO T 11 - Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
2. AASHTO T 27 - Sieve Analysis of Fine and Coarse Aggregates
3. AASHTO T30 - Mechanical Analysis of Extracted Aggregate
4. AASHTO T 89 - Determining the Liquid Limit of Soils
5. AASHTO T 96 - Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
6. AASHTO T 104 - Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
7. AASHTO T 180 - Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
8. AASHTO T 205 – Density of Soil In-Place by the Rubber-Balloon Method
9. AASHTO T 238 - Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
10. AASHTO T 239 - Moisture Content of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)

B. American Society for Testing and Materials International:
1. ASTM C127 - Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
2. ASTM C128 - Relative Density (Specific Gravity) and Absorption of Fine Aggregate
3. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates

4. ASTM D1188 - Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
5. ASTM D2171 - Viscosity of Asphalts by Vacuum Capillary Viscometer
6. ASTM D2726 - Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
7. ASTM D2950 - Density of Bituminous Concrete in Place by Nuclear Methods

C. Asphalt Institute Manuals:
1. MS-2 – Asphalt Mix Design Methods
2. MS-4 – The Asphalt Handbook

1.03 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Aggregate: Material certificates and laboratory analysis.
2. Prime and tack coats: Material certificates for each load.
3. Asphaltic Concrete:
   a. Job mix formula for each type supported by:
   b. Evidence of mix design procedure.
   c. Complete aggregate analysis.
   d. Marshall curves.
   e. Mixing and placing temperatures.
   f. Job mix formula may be one successfully used in the area if supported by recent certified test reports.

1.04 TESTING AND INSPECTION

A. Testing: Take representative samples from the asphalt plant and the laydown surface and test in accordance with the following standard test procedures:
1. Bulk Specific Gravity of Compacted Bituminous Mixtures: ASTM D1188 or ASTM D2726.
2. Quantitative Extraction of Bitumen from Bituminous Paving Mixtures: ASTM D2171.
3. Sieve or Screen Analysis of Fine and Coarse Aggregates (extracted sample): ASTM C136.
4. Density of Bituminous Concrete in Place:
   a. Nuclear Method ASTM D2950 or,
   b. ASTM D1188 or ASTM D2726.

PART 2 PRODUCTS

2.01 MATERIALS

A. Subgrade: Existing in-place soil except that organic materials, solid obstructions, muck and other unsuitable materials shall be removed. Filling pockets in the subgrade with base course material or asphalt will generally not be permitted.

B. Crushed Aggregate Base Course: Base course aggregate shall be composed of materials consisting of crushed stone, crushed or screened gravel, caliche, sand or a combination of such materials. Base course aggregate shall be free from vegetable matter and all other deleterious materials. When the stationary plant method is used, base course aggregate will be accepted immediately following mixing based on periodic samples taken from the pugmill output. When a road mix method is used, base course aggregate will be tested for acceptance on samples taken from the watered and completely processed window.

1. Base course aggregate will be tested in accordance with AASHTO methods provided below or in accordance with other approved methods:

Mechanical Analysis	AASHTO T 27
Passing No. 200 Sieve	AASHTO T 11
Liquid Limit	AASHTO T 89
Los Angeles Abrasion	AASHTO T 96
Soundness (5 cycle- Magnesium Sulfate Solution)	AASHTO T 104
Linear Shrinkage Materials Testing Control Manual	

2. Base course aggregate materials shall be combined in such proportions that the resulting composite blend meets the requirements of one of the following classes:

Sieve Size	Class A	Class B
1”	100	100
3/4”	80-100	85-100
No. 4	30-60	40-70
No. 10	20-45	30-55
No. 200	3-10	4-12
Soundness	18 or less	18 or less
L.A. Abrasion	50 or less	50 or less
L.L.	25 or less	25 or less

3. Fifty percent by weight of all plus No. 4 materials shall have a minimum of two mechanically fractured faces.

C. Prime and Tack Coats: Emulsified asphalt suitable for the intended use and local soil conditions.

D. Asphaltic Concrete: Mixture of mineral aggregate and paving asphalt (asphalt cement) mixed at a central mixing plant delivered as specified:

1. Asphalt cement: As recommended in the approved job-mix formula.

2. Aggregates:
   a. Tested in accordance with the following AASHTO methods:

Mechanical Analysis	AASHTO T 30
Passing No. 200 Sieve	AASHTO T 27
Liquid Limit	AASHTO T 89
Los Angeles Abrasion	AASHTO T 96
Soundness (Magnesium Sulfate)	AASHTO T 104

   b. Asphalt concrete aggregate shall have a percent of wear of 40 or less and the course aggregate shall have a soundness loss of 15 or less. All material passing the No. 40 sieve shall be non-plastic. The amount of crushing shall be regulated so that at least 60 percent, by dry weight, of the plus No. 4 sieve material shall have a minimum of 2 fractured faces.

   c. Gradation requirements:

Class "A"

Sieve Size	% Passing
1"	100
3/4"	80-100
1/2"	60-90
3/8"	50-80
No. 4	33-60
No. 8	23-45
No. 40	7-20
No. 200	2-8

Class "B"

Sieve Size	% Passing
3/4"	100
1/2"	75-95
3/8"	65-85
No. 4	40-60
No. 10	32-45
No. 40	10-22
No. 200	3-8

The grading of the combined aggregates as selected for the job mix design, shall be within the designated limits, and shall not vary from the high limit on one sieve to the low limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine. The percentages shown are based on the weight of dry aggregate only. Sieve analysis shall be made in accordance with ASTM C136 or AASHTO T 30.

3. Proportioning: The job-mix formula designed to achieve the following test properties subject to verification by field testing:

	Surface Course
Stability (Marshall - 75 Blow Briquette)	1500 lbs.+
Flow (Marshall)	8-16
Percent of Voids	3-7
Percent of Voids Filled With Asphalt	75-85
Percent Asphalt Cement Content by Weight	
Optimum of Total Mix	+0.4%
Sand Equivalent	40 or more
Compaction (% of max. laboratory density)	96% minimum

4. Tolerances: If a mixture produced varies from the designated amounts by more than the following tolerances, proper changes shall be made until subsequent mixtures are within those tolerances:

Passing No. 4 and larger sieves	+7 percent
Passing No. 8 to No. 100 sieves (incl.)	+4 percent
Passing No. 200 sieve	+2 percent
Bitumen (tank strap method)	+0.3 percent
Bitumen (extraction method)	+0.5 percent
Temperature of Mixture	+20 degrees F
Hydrated Lime	+0.3 percent
Portland Cement	+0.3 percent

5. Voids: For the purpose of calculating the percentage of voids in total mix and voids filled with asphalt, the specific gravities of the various aggregates shall be selected as follows:
   a. When the absorption of the aggregate, as determined by applicable ASTM C128 or ASTM C127, is less than one percent, the apparent specific gravity shall be used.
   b. When the absorption of the aggregate, as tested by ASTM C128 or ASTM C127, is one percent or greater, the mean between the bulk and the apparent specific gravities shall be used.

E. Open Graded Friction Course: Mixture of crushed stone or crushed gravel and bituminous materials mixed at a central mixing plant delivered as specified:
1. Asphalt Cement: As recommended in the approved job-mix formula.
2. Aggregates:
   a. Shall be crushed stone or crushed gravel, composed of hard durable pebbles or fragments so as to provide a material that will meet the following grading requirements when tested by means of AASHTO T 11 and T 30.
   b. At least 75 percent of the material retained on the No. 4 Sieve shall be particles having at least two fractured faces.

c. Shall be free from vegetable matter, lumps or balls of clay, adherent films of clear or other material that will prevent through coating with asphaltic material.
d. Shall have a percentage of wear of not more than 40 or less, and shall have a soundness loss of 8 or more.
e. Shall be from a single source, blending from multiple source will not be permitted.
f. Gradation Requirements:

Sieve Size	% Passing
1/2”	100
3/8”	90-100
No. 4	25-55
No. 10	0-10
No. 40	0-8
No. 200	0-4

F. Mine tailings may be incorporated into the work only with the prior specific written approval of the Engineer.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Rough Grading Requirements: Section 31 23 00 – Excavation and Fill

B. Any underlying soft or otherwise unsuitable material shall be removed and replaced with suitable material from excavation or borrow.

C. Scarified, watered, and compacted to 95% of modified Proctor density (AASHTO T 180) at optimum moisture content plus or minus (±) 2%, to a depth of 12” minimum.

D. Subgrade upon which pavement, sidewalk, curb and gutter, driveways or other structures are to be directly placed shall not vary more than 1/4 inch from the specified grade and cross section. Subgrade upon which subbase or base material is to be placed shall not vary more than 1/2 inch from the specified grade and cross section. Variations within the above specified tolerances shall be compensating so that the average grade and cross section specified are met.

3.02 CRUSHED AGGREGATE BASE COURSE

A. Subgrade:
1. Cleaned of all loose and deleterious materials.
2. Free from frozen material.
3. Top 6 inches shall have a moisture content not exceeding optimum plus or minus 2 percent as determined by AASHTO T 180.

B. Mixing and Placing:
   1. Mixing shall provide a homogenous mixture of unsegregated and uniformly dispersed materials as placed in position for compacting.
   2. Plant and equipment shall be adequate in all respects.
   3. Spread and compact base course in layers which will permit the required density to be obtained.
   4. Density requirements will be determined by AASHTO T 180.
   5. Unless otherwise provided, base course compacted to not less than 100 percent of the laboratory established density.
   6. Densities will be determined in compliance with AASHTO T 205, use of nuclear methods in conformity with AASHTO T 238 and T 239, or other approved methods.
   7. Top surface of base course shall not deviate in excess of 1/4 inch when tested with a 10-foot straightedge in any direction. All deviations from this tolerance shall be corrected.

C. Acceptable Mixing and Placing Methods:
   1. Stationary Plant Method:
      a. Base course material and water mixed in an approved mixer.
      b. Water added during the mixing operation in the amount necessary to provide the optimum moisture content for placement plus or minus two percentage points.
      c. The base course material transported to the job site while it contains the proper moisture content and placed without delay on the roadbed by means of an approved aggregate spreader.
   2. Travel Plant Method:
      a. Material for each layer of base course placed through an aggregate spreader or window sizing device.
      b. Base uniformly mixed by a traveling mixing plant.
      c. During mixing, water added in an amount sufficient to provide the optimum moisture content plus or minus two percentage points at the time of placement of material.
   3. Road Mix Method:
      a. Material for each layer of base course placed.
      b. Materials mixed by means of motor graders or other suitable equipment until the mixture is uniform throughout.
      c. Water added during mixing sufficient to provide the optimum moisture content plus or minus two percentage points at the time of placement of material.

3.03 PRIME COAT

A. The use of prime coat shall be optional with the Contractor, recognizing that its primary value is in protecting the base course before it is covered with the asphalt surface course. If prime coat is used, it shall be so applied that it will penetrate and seal, but not flood, the base course surface. Any excess prime coat shall be dried up

with blotter sand. Prime coat shall be properly cured out before the surface course is placed.

3.04 TACK COAT

A. The contact surfaces of all cold pavement joints, curbs, gutters, manholes, and the like, shall be cleaned and painted with tack coat just before the adjoining asphaltic concrete is placed.

B. Where multi-lift construction is called for, a light tack coat shall be used between lifts if the underlying surface has become dirty or give other signs that the lifts may not bond together properly without the aid of a tack coat. However, tack coat shall be used as sparingly as possible to achieve the intended purpose.

3.05 ASPHALTIC CONCRETE

A. The base course shall be cleaned, inspected, and all deficiencies corrected well in front of the laydown machine. Removing deficient base course material and filling the pocket with asphaltic concrete will not generally be permitted.

B. Manhole frames and valve covers shall be adjusted prior to placing the surface course.

C. At the time of delivery to the site of the work, the temperature of mixture shall be not lower than that required to obtain the density specified.

D. When hauling time from the mixing plant to the job site exceeds two hours or when inclement weather prevails, bituminous mixtures shall be covered with tarpaulins while being hauled. The tarpaulins shall completely cover the load and be firmly tied down. Mixtures shall be delivered to site of the work without segregation of the ingredients.

E. Asphalt concrete may be placed when the temperature is 40ºF and rising and the weather is favorable as determined by the Engineer. None may be placed in wet weather or on a wet surface.

F. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that after rolling it will be of the specified cross section and grade of the course being constructed.

G. Depositing and spreading of the asphalt concrete shall be accomplished by means of self-propelled mechanical spreading and finishing machine designed especially for that purpose and which permits depositing and spreading in a strip 8 to 14 feet in width. The machine shall be equipped with a vibrating or tamping screed capable of being accurately regulated and adjusted to distribute a layer of the material to a definite predetermined thickness and template. The paving machine shall be equipped with an automatic leveling device controlled from an external guide. The initial pass for each course shall be made using a paver equipped with a 40-foot

minimum external reference, except this shall not apply when asphaltic concrete is placed adjacent to concrete pavement or gutter. Subsequent passes shall utilize a matching device of 1-foot minimum length, riding on the adjacent lift.

H. Placing once commenced must be continued without interruption. No greater amount of the mixture shall be delivered in any one day than can be properly distributed and rolled during that day during daylight hours.

I. In narrow, deep or irregular sections, intersections, turnouts, or driveways, where it is impractical to spread and finish the base and level the surface mixtures by machine methods, the Contractor may use spreading equipment or acceptable hand methods reviewed by the Engineer.

J. Care shall be exercised in connection with the construction of joints to ensure that the surface of the pavement is true to grade and cross section.

K. In making the joint along any adjoining edge such as a curb, gutter, or an adjoining pavement and after the hot mixture is placed by the finishing machine, sufficient hot material shall be carried back to fill any space left open. This joint shall be properly "set up" with the back of a rake at proper height and level to receive the maximum compression under rolling. The work of "setting up" this joint shall be performed by competent workmen who are capable of making a correct, clean, and neat joint.

L. Longitudinal and transverse joints shall be made in a careful manner. Well-bonded and sealed joints are required. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to insure a thorough and continuous bond between the old and new surfaces. In the case of surface course, the edge of the old surface course shall be cut back for its full depth so as to expose a fresh surface and, if necessary, to obtain a well-bonded joint, shall be painted with a tack coat after which the hot surface mixture shall be placed in contact with it and raked to a proper depth and grade. Before placing mixture against contact surfaces of curbs, gutters, headers, manholes, etc., they shall be painted with a tack coat.

M. Rolling shall be commenced with a steel wheel roller along the lower edge of the area to be rolled and be continued until the edge is thoroughly compacted, after which the roller shall be gradually advanced to the crown point, both sides being rolled in a like manner. Rolling shall be continued with steel and pneumatic wheel rollers until the layer has become thoroughly compacted throughout and is true to grade and cross section.

N. Rollers shall be maintained in good mechanical condition, and those that cannot be operated without jerking or driven along a straight path shall not be used. No leakage from any roller shall be allowed to come in contact with the pavement being constructed nor shall any roller be permitted to stand motionless on any portion of the work before it has been properly compacted. Steel roller wheels shall be treated with water or oil to prevent the adherence of the asphalt concrete, and water or oil may be

used on pneumatic-tired rollers but the quantity used must not be such as to be detrimental to the surface being rolled.

O. Final rolling of the top or finish course shall be accomplished with a steel wheel roller, removing all surface imperfections, including indentures made by pneumatic-tired rollers.

P. Rolling of any asphaltic concrete course shall be continued until all roller marks are eliminated and a density of at least 96% of the density of a laboratory specimen of the same mixture has been obtained.

Q. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand operated mechanical tampers. Any mixture that becomes mixed with foreign materials or in any way is defective shall be removed, replaced with fresh mixture, and compacted to the density of the surrounding pavement.

R. Upon completion, the pavement shall be true to grade and cross section. Except at intersections or any changes of grade, when a 10-foot straightedge is laid on the finished surface parallel to the centerline of the roadway, the surface shall not vary from the edge of the straightedge more than 3/16 inch. Areas that are not within this tolerance shall be brought to grade immediately following the initial rolling. After the completion of final rolling, the smoothness of the course shall be checked, and the irregularities that exceed the specified tolerances or that retain water on the surface shall be corrected by removing the defective work and replacing with new material as directed by the Engineer at the expense of the Contractor.

S. The Contractor shall cut samples as requested by the Engineer for testing the in-place compacted thickness of any asphaltic concrete course. Any area found to be more than 1/4” deficient in thickness shall be removed and satisfactorily replaced by the Contractor. If the average of all the thickness tests indicate that the entire course is deficient in excess of 1/8”, the Contractor shall provide a 1” asphaltic concrete surface course overlay at no additional cost to the Owner or other corrective action as reviewed by the Engineer.

3.06 RESTORATION OF EXISTING SURFACES

A. Roadways, parking areas, other traveled areas not scheduled:
1. Fully restored equivalent to what existing surfacing would have been when new.
2. Materials and installation as appropriate to conform to this Section.
3. Thickness, grades, alignment, and materials to match existing.
4. All work performed on NMDOT right-of-way shall meet the Standard Specifications for Road and Bridge Construction (current edition) and conform with NMDOT requirements.
5. All pavement cuts to be by saw or other methods to give straight edges and lines.
6. Asphalt pavement to be placed with laydown machine when practical.

7. Pavement removal and replacement payment limit: Pipe outside diameter plus 40” for all non-scheduled surfaces regardless of width actually removed and replaced.

3.07 SCHEDULE OF THICKNESSES AND GRADATION

A. Thickness required as shown on the Drawings.

B. Gradation shall be Class “B”.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to work of this section.

B. The Contractor shall provide all labor, materials and appurtenances for the complete installation of hot-dipped galvanized chain link fence system.

C. The extent of each type of chain link fencing is indicated on drawings and by the provisions of this section.

1.02 SUBMITTALS

A. Shop Drawings: Clearly indicate plan layout, grid, spacing of components, accessories, fittings, and anchorage.

B. Product Data: Submit manufacturer's product data, installation instructions, and general recommendations for each product specified.

1.03 QUALITY ASSURANCE

A. Completion of ten equivalent installations.

PART 2 PRODUCTS

2.01 FABRIC

A. Zinc-coated fabric shall be galvanized before weaving (GBW) with a minimum 1.2 ounces of zinc per square foot of surface area and conform to ASTM A-392, Class 1.
1. Wire Size: The finished wire size shall be 9 gauge.
2. Nominal diameter of coated wire to be 0.148″.

B. Height of fencing is indicated on the Drawings.

C. Fabric Schedule:

Usage	Size of Mesh	Selvage	
		Top	Bottom
Perimeter	2″	twisted	knuckled

2.02 FRAMEWORK

A. Posts, gate frames, braces and horizontal rails shall be:
   1. Industrial fence round pipe post, manufactured from high tensile steel pipe cold formed and welded per ASTM F1043, Group 1B, having a minimum yield strength of 50,000 PSI.
   2. The external zinc coating shall be Type B zinc (ASTM B6) with 0.9 oz/ft^2.
   3. The internal coating shall be Type B zinc (ASTM B6) with 0.9 oz/ft^2 or Type D, 81% nominal zinc pigmented coating with 0.3 mils minimum thickness.

B. Framework Dimensions and Weights:

1. Use and Section	Nominal OD - Inches	Nominal Weight/Foot Lbs/Ft
End corner and pull posts fabric height		
6′0″ and less, round	2.375	3.12
Over 6′0″, round	2.875	4.64
Intermediate (Line) posts fabric height		
6′0″ and less, tubular	1.90	2.28
Over 6′0″, tubular	2.375	3.12
Gate posts, nominal width of gate, single or one leaf of double gate		
6′0″ or less, round	2.875	4.64
Over 6′0″ to 13′0″, round	4.00	6.56
Over 13′0″ to 18′0″, round	6.625	18.97
Over 18′0″, round	8.625	24.70
Gate frames		
6′0″ or less in height, 8′0″ or less in width, round	1.660	1.83
Over 6′0″ in height 8′0″ in width, round	1.90	2.28
Rails and post braces	1.66	1.83

   2. Horizontal Railing:
      a. Top rail shall be supplied in 21-foot lengths and joined by 6″ long sleeves and run continuously along the top of the fence through openings provided in the line post tops.
      b. Top rail shall be 1.66″ OD weighing 1.83 lbs. per linear foot.
      c. Bottom rail, middle rail and bracing are optional and shall be the same as specified for top rail when required.

2.03 ACCESSORIES

A. Caps: Cast or pressed steel, or malleable iron, hot dip galvanized, sized to post dimension.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings, shall be of galvanized press steel, malleable or cast steel as specified in ASTM F626 and FS RR-F-191.

C. Top and Bottom Tension Wire: 7-gauge steel single strand, galvanized.

D. Extension Arms: To accommodate 3 strands of barbed wire, sloped 45 degrees or razor ribbon coil.

E. Barbed Wire: 12-1/2-gauge wire, 3 strands, 4-point, Type Z, Class 3 (0.80 oz/ft^2, zinc-coated (galvanized),14 gauge round barbs on 5″ centers.

F. Gates: As indicated in the drawings, gates shall be swing or sliding as required, complete with latches, stops, keepers, hinges or rollers and roller tracks, and when required, with provision for three strands of barbed wire above the fabric.
   1. Swing gates shall conform to ASTM F900 and FS RR-F-191.
   2. Slide gates shall conform to ASTM F1184.
   3. Gate Hardware:
      a. Gate center rest, 2 pieces drop latch, chain gate holdback, gate hinge 180-degree male and female, fork latch and latch catch, drop bolt, hardware for padlock.
      b. Gate hardware shall be in accordance with ANSI 404.2.7 and be 34″ minimum to 48″ maximum above the ground.

2.04 CONCRETE

A. 3000 psi, 2″ -3″ slump, Section 03 30 00

PART 3 EXECUTION

3.01 INSTALLATION

A. The complete fence shall be plumb, both in line and transverse to the fence, straight and rigid with fabric tightly stretched and held in place firmly.
   1. Set posts in concrete footings as specified in CLFMA standard.
   2. Install chain link in accordance with Practice F567.

B. Post Setting:
   1. Set fence posts at spacings of a maximum of 10′-0″ on center.
   2. Gate posts shall be spaced according to the gate openings specified in the Drawings.
   3. Set end, gate and line posts in concrete footings.
   4. Set post to within 6″ from bottom of concrete footing.

5. Top of footing shall be 2″ above grade and sloped to direct water away from posts.
6. Concrete footing:
    a. Line Posts 12″ diameter x 2′-6″ deep.
    b. Corner, Pull and End Posts: 12″ diameter x 3′-0″ deep.
    c. Gate Posts 4″ O.D and Smaller: 12″ by 12″ Concrete base with embedded iron angle.

C. Fabric:
1. Attach fabric to security side.
2. Pull fabric taut with bottom selvage 2″ above grade.
3. Fasten to end posts with tension bars threaded through mesh and secured with tension bands at maximum 15″ intervals.
4. Tie to line posts and top rails with tie wires spaced at maximum 12″ on posts and 24″ on rails.
5. Attach to bottom tension wire with top rings at maximum 24″ intervals.

D. Security Wire:
1. Install 3 strands of barbed wire on arms.
2. Anchor to end extension arms, pull taut and firmly install in slots of line post extension arms.

E. Gates:
1. Install gates as shown on Drawings.

3.02 SCHEDULE

A. Provide heavy-duty industrial padlock, keyed to match Owner’s master lock system.

B. As shown on Drawings.

END OF SECTION

SECTION 33 05 23.01

JACKING AND BORING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Boring, drilling or jacking operations for casing for water pipe, sanitary sewer pipe, storm sewer pipe, and traffic conduit in areas where trenching is not feasible.

B. Contractor shall maintain at all times a file at the job site containing New Mexico Department of Transportation (NMDOT), railroad, or other permits required to perform the work.

1.02 RELATED WORK

A. Section 01 71 23.17 – NMDOT Utility Permit Survey Requirements.

B. Section 31 23 33 – Trenching and Backfilling.

C. Section 33 31 01 – Sanitary Sewerage Systems.

D. Section 40 27 00 – Process Pipe Systems.

1.03 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples: Product data for all materials and appurtenances specified in Part 2 PRODUCTS.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Casing:
1. ASTM A 139 – Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over), Grade B, complete joint penetration groove welds, grooved ends.
2. Size and thickness:

Steel Casing Diameter Nominal / I.D.	Steel Casing Nominal Wall Thickness	Nominal Ductile Iron Carrier Pipe Size
16″/15.25″	.375″	6″
16″/15.25″	.375″	8″
20”/19.25″	.375″	10″

Steel Casing Diameter Nominal / I.D.	Steel Casing Nominal Wall Thickness	Nominal Ductile Iron Carrier Pipe Size
24″/23.00″	.500″	12″
24″/23.00″	.500″	14″
30″/29.00″	.500″	16″
30″/29.00″	.500″	18″
36″/35.00″	.500″	24″
42″/41.00″	.500″	30″
Or as scheduled.		

B. Carrier Pipe:
1. 12″ HDPE (DIP Size): Thermal butt fusion joints.
2. Extend carrier pipe and restrained joints 1'-0″ beyond each end of casing.

C. Cathodic Protection for Casing:
1. Galvanic Anodes – Material:
   a. Magnesium high-potential anodes: Required to meet the minimum weights and sizes as shown on the Drawings. Cores to extend at least 75% of anode length. Pre-wired at factory with #12 copper TW, red in color; ASTM B843, for M1C anodes. ASTM G97.
   b. Chemical Composition:
      1) Aluminum – 0.01% max.
      2) Manganese – 0.50-1.3%.
      3) Silicon – 0.05% max.
      4) Copper – 0.02% max.
      5) Nickel – 0.001% max.
      6) Iron – 0.03% max.
      7) Others, each – 0.05% max.
      8) Remainder – Magnesium.
   c. Acceptable Manufacturers:
      1) Garfield Alloys – Maxmag anode.
      2) Timminco Metals – Galvomag anode.
2. Anode Installation:
   a. All anodes on casings shall be 17# pre-packaged anodes, or approved equal. Each casing shall have two (2) 17# anodes (one at each end).
   b. The installed anode shall meet all of the following criteria upon complete installation by the Contractor:
      1) The anode will be located a minimum of 3′ and a maximum of 10′ horizontally from the pipe/casing. All anodes will be installed vertically. All anodes will be installed at a depth to assure that the top of the anode is below the top of the pipe/casing.
      2) The anode wire will be wrapped once around the pipe/casing and tied off to provide an anchor point between the anode and the cadweld.
      3) The anode wire shall have a minimum burial depth of 3′ throughout its length.

4) A minimum of 5 gallons of water shall be used to wet the anode prior to backfilling.
5) The soil adjacent to and above the anode shall be compacted as specified for the pipeline.

c. Cadwelding (Thermite Brazing) Procedure:
1) Cadweld materials and procedures only are approved for use in affixing permanent conductors to steel pipe/casing.
2) Remove 6″ x 4″ section of coating from the top of the pipe/casing.
3) The exposed metal of the pipe/casing will be cleaned to a shining metal surface in preparation for cadwelding. The cleaning operation shall employ either filing or power brushing.
4) The cadwelding shall employ Cadweld #15 cartridges for steel piping. Proper sleeves shall be crimped on the anode wires in accordance with the manufacturer's recommendation. All cadwelding shall employ like-new (no slop) molds. All vertical riser cadwelds shall use vertical molds only.
5) The completed cadweld shall be allowed to cool 1 full minute prior to application of primer and tape.
6) The exposed metal surface and the cadwelded area shall be primed and taped.

2.02 APPURTENANCES

A. Casing Spacer:
1. Shell and Risers: T-304 passivated stainless steel or fusion bonded thermoplastic powder coated steel, 14 gage minimum, flanges ribbed for strength, two-piece bolt-on shell, 8″ wide minimum, three bolts per flange.
2. Liner: PVC or EPDM, 0.090″ thick, 85-90 durometer "A", overlap edges, ribbed.
3. Runners: UHMW polymer or glass filled polymer, mechanically attached to risers or shell.
4. Fasteners: T-304 stainless steel, 5/16″.
5. Acceptable Manufacturers:
a. Cascade Waterworks Manufacturing Company, Model CCS.
b. Advance Products and Systems, Inc., Model SSI, SI, SSIM and SIM.
c. Engineer reviewed equivalent.

B. Casing End Seals:
1. Construction: Rubber seal with steel bands.
2. Seal: Virgin SBR Rubber.
3. Bands: T-304 stainless steel.
4. Wrap-around seam sealed with bonding cement or mastic.
5. Acceptable Manufacturers:
a. Cascade Waterworks Manufacturing Company, Model CCES
b. Advance Products and System, Inc., Model AC, AW, or AZ.
c. Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Water, Sewer, and Storm Drain:
   1. Completed to the alignment and grade shown on the construction drawings.
   2. Earth and/or rock augers shall not exceed the O.D. of the steel casing by more than 1/4″.
   3. Use equipment for boring and insertion of steel casing capable of simultaneous operation.
   4. Feed rate of augers and hydraulic pushing of the casing shall be the same.
   5. Avoid loss of earth.
   6. Excavated material shall be removed from the casing as excavation progresses and no accumulation of such material within the casing shall be permitted.
   7. Fill voids around the outside face of the casing by grouting when operation is complete.
   8. Grouting equipment and material shall be on the job site before boring operations are started in order that grouting around the bored casing may be started immediately after the boring operations have finished.
   9. Carrier pipe shall be skidded through the casing on casing spacers in centered positioning.
   10. Place casing spacers within 2′ from each end of the casing. Place three spacers on first pipe section, then two every pipe section thereafter, at each joint, and at the center of each carrier pipe section.
   11. Modify casing spacer placement to meet spacing manufacturer and pipe manufacturer recommendations.
   12. Contractor to locate all underground and overhead utilities before beginning boring operations and shall repair any damage to utilities resulting thereto.
   13. Only workmen experienced in the boring operation shall perform the work.

B. Electrical Conduit:
   1. Use approved jacking or drilling methods.
   2. Non-metallic conduit shall not be installed by jacking.
   3. Non-metallic conduit shall be installed by drilling if a hole larger than the conduit is pre-drilled and the conduit is hand-installed.
   4. Jacking or drilling pits shall be at least 2′ from the edge of any type of any pavement, measured from the side of the pit nearest to the pavement.

C. Backfilling Entry and Exit Pits:
   1. Conform to the requirements of Section 31 23 33 – Trenching and Backfilling.

3.02 FIELD QUALITY CONTROL

A. Tolerances:
   1. Installation to be sound, tight, and true to line and grade.
   2. Allowable tolerance as to grade and alignment of the installed casing shall not exceed 1/10 of a foot per hundred feet of casing length.

3.03 SCHEDULE

A. As shown on Drawings.

END OF SECTION

SECTION 33 05 61

SANITARY SEWERAGE MANHOLES, FRAMES, AND COVERS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Round access manholes with open channel invert for gravity piping systems, complete with frames, covers, and other necessary appurtenances.

B. Manholes used over gravity pipe channels.

1.02 RELATED WORK

A. Section 03 30 00 – Cast-in-Place Concrete.

B. Section 09 97 01 – Industrial Coatings.

C. Section 33 05 61.01 – Utility Manholes, Frames, and Covers.

D. Section 33 31 01 – Sanitary Sewerage Systems.

1.03 REFERENCES

A. American Society for Testing and Materials International (ASTM):
1. ASTM A48 – Gray Iron Castings.
2. ASTM C207 – Hydrated Lime for Masonry Purposes.
3. ASTM C387 – Packaged Dry, Combined Materials for Mortar and Concrete.
4. ASTM C478 – Circular Precast Reinforced Concrete Manhole Sections.
5. ASTM C990 – Joints for Concrete Pipe Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data.
2. Materials of construction.
3. Dimensioned Drawings.
4. Weights.
5. Conformance to referenced standards.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Section 03 30 00 – Cast-in-Place Concrete.

B. Precast Sections:
   1. ASTM C478.
   2. Minimum wall thickness: 4".

C. Hydrated Lime: ASTM C207, Type S.

D. Mortar: ASTM C387, or 1 part Portland cement, 1/2 part hydrated lime, 3 parts sand.

E. Gaskets:
   1. Description: Preformed flexible joint sealant.
   2. Material: Butyl-rubber and/or refined hydrocarbons, resins, and plasticizing compounds.
   3. Conformance: ASTM C990.

F. Pipe Waterstops: Elastomeric PVC or neoprene ring manufactured to form watertight seal around pipe and be embedded in grout.

G. Drop Manhole Pipe and Fittings:
   1. Pipe material and type to match sewer line.
   2. Or ductile iron.

H. Standard Ring and Cover:
   1. Material: Gray cast iron, ASTM A48, Class 35B.
   2. Duty: Heavy duty, rated for H-20 truck traffic.
   3. Clear Opening: 22" minimum, or as indicated on Drawings.
   4. Vent: Vented.
   5. Pickhole: Open.
   6. Ring Flange: Bottom flange for built-up type installation, top flange where embedded slab style installation is shown on Drawings.
   7. Combined Ring and Cover Weight: 260 lb. minimum.
   8. Cover Pattern: Word "SEWER" cast into center of cover.
   9. Seating: Covers to seat at all points on ring. Grind bearing surfaces to prevent rocking.

I. Watertight Ring and Cover for Pressure Manholes:
   1. Material: Gray cast iron.
   2. Style: Watertight, bolted lid with neoprene gasket glued to frame, rated to 20 psi.
   3. Bolts: Stainless steel, countersunk, hex head.
   4. Duty: Heavy duty, rated for H-20 truck traffic.
   5. Clear Opening: 20-1/16" minimum.
   6. Vent: None.
   7. Pickhole: Concealed. (Closed.)
   8. Ring Flange: Bottom flange with anchor holes.
   9. Cover Pattern: Word "SEWER" cast into center of cover.
   10. Seating: Covers to seat at all points on ring. Grind bearing surfaces to prevent rocking.
   11. Design Basis: Neenah Foundry model R-1915-S1, or Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 FABRICATION

A. Manhole Section:
1. Precast.
2. Minimum inside dia.: 48", or as indicated on Drawings or scheduled herein.
3. Eccentric cones for manholes 6' deep and greater.
4. Flat, concrete manhole covers for manholes less than 6' deep.
5. Cones: Same or greater reinforcement and wall thickness as manhole section.
6. Manhole steps: None.
7. Joints: Keylock type with preformed gaskets or mastic seal.
8. Manhole clear opening: 22" minimum, or as indicated on Drawings.
9. Drop structure: As indicated on Drawings.

B. Manhole Height Adjustment:
1. Use precast grade adjustment rings.
2. 6" maximum adjustment height above cone to bottom of ring and cover if manholes require steps.
3. 12" maximum adjustment height above cone to bottom of ring and cover if manholes do not require steps.

C. Placing Precast Manhole Sections:
1. Clean ends of sections and apply cold bituminous mastic to both sections, or install preformed gasket.
2. Completed manholes shall be rigid.
3. Completed manholes shall be watertight to the extent that they shall meet both the exfiltration and infiltration tests specified herein.

D. Preformed Gaskets:
1. Manhole sections with chipped or cracked joints shall be rejected.
2. Thoroughly clean section joints.
3. Install gasket in conformance with manufacturer's recommendations.
4. Only use primer furnished by gasket manufacturer.

E. Interior Manhole Finish – Precast Section:
1. Remove excess mastic flush with precast sections.
2. Mortar in joint openings flush with precast sections.
3. Fill in any chipped areas.

F. Manhole Invert:
1. Place concrete in bottom of manhole and form smooth transition.
2. Invert shape to conform to radius of pipe it connects.
3. Remove all rough sections or sharp edges which tend to obstruct flow or cause material to snag.
4. Construct in conformance with standard drawings.

G. Drop Assemblies:
1. Construct as shown on Drawings.

H. Pipe Joints:
1. Provide joint in rigid sewer pipe within 2’ of manhole.
2. Seal pipe penetrations through barrel using pipe waterstop and grout.

I. Pipe Stubouts for Present and Future Connections:
1. Install where shown on Drawings.
2. Provide drops as shown.
3. Form smooth invert
4. Length: 5’ max., 1’ min., unless otherwise shown on Drawings.
5. Place watertight temporary plug in all stubouts.
6. Brace plug against blow-off.

J. Permanent Plugs:
1. Thoroughly clean contact surfaces or pipes to be abandoned or cut off.
2. Pipes 18” dia. and less: Place 18” thick concrete plug.
3. Pipes greater than 18” dia.: Plugs can be brick or concrete block with out-side face plastered with mortar.

K. Temporary Plugs During Construction:
1. Install 2” plywood plug in joint.
2. Backfill against plug.

L. Manhole Rings and Covers:
1. Place rings in bed of mortar on top of manholes.
2. Ensure no infiltration will enter manhole at this location.
3. Carry mortar over flange of ring.
4. Ring setting:
   a. Top to be flush with all surfaces subject to foot and vehicular traffic.
   b. Top to be 4” above surfaces in open, untravelled areas or as shown on Drawings.

M. Manholes Over Existing Sewers:
1. Construct manhole base and install manhole sections as for new manholes. Carefully consolidate cast-in-place concrete underneath existing pipe to remove all voids.
2. Maintain flow at all times.
3. Prior approval of proposed method for maintaining flow must be obtained from Engineer.
4. Break out crown of existing pipe and make invert.
5. Cover the edges of the broken pipe with mortar and trowel smooth to the new invert.

N. Connection to Existing Manholes:
1. Make connection during low flow periods.
2. Maintain flow at all times.
3. Prior approval of proposed method for maintaining flow must be obtained from Engineer.
4. Break into existing manhole and reform invert to provide smooth flow transition.

5. Cover area around new pipe with mortar to ensure a watertight structure.

O. Manhole Interior Coating for Corrosion Protection:
1. Apply a C2 coating per Section 09 97 01 – Industrial Coatings.
2. Perform Holiday Test per Section 09 97 01 – Industrial Coatings.

P. Exterior Coating:
1. Dampproofing Coating C6 per Section 09 97 01 – Industrial Coatings.

3.02 FIELD TESTING

A. Leakage Testing: Test all manholes on gravity lines by either hydrostatic or vacuum testing, unless directed otherwise by Engineer.
1. Hydrostatic Testing:
   a. Plug all inlets and outlets.
   b. Fill manhole to 3/4 height.
   c. Allow water to stand for 24 hours.
   d. Leakage tested during following 24-hour period.
   e. Leakage: Less than 0.2 gph/ft above invert.
   f. Repair and retest all manholes that do not meet leakage test.
2. Vacuum Testing:
   a. Plug all inlets and outlets.
   b. Utilize an inflatable compression band, vacuum pump, gauges, and appurtenances specifically designed for vacuum testing.
   c. Test in accordance with the manufacturer's recommendations.
   d. The Engineer shall be the sole judge as to the adequacy of the equipment.
   e. A vacuum of 10" Hg shall be placed in the manhole and the time measured for a drop to 8.5" Hg. The test shall be considered to be successful if the measured time exceeds the test period. Should the test fail, the manhole shall be repaired as necessary and the test rerun. The test periods are:
      1) 60 seconds for 4' diameter manholes.
      2) 75 seconds for 5' diameter manholes.
      3) 90 seconds for 6' diameter manholes.
      4) 120 seconds for 8' diameter manholes.

B. Infiltration Testing:
1. No visible running or dripping water.
2. Repair all manholes that do not meet infiltration test.

3.03 SCHEDULE

A. As shown on Drawings.

END OF SECTION

SECTION 33 05 61.01

UTILITY MANHOLES, FRAMES, AND COVERS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Round utility and piping access manholes complete with frames, covers, and other necessary appurtenances.

B. Manhole valve vaults.

1.02 RELATED WORK

A. Conditions of the Contract: Definitions and Additional Responsibilities of Parties.

1.03 SHOP DRAWINGS

A. American Society for Testing and Materials International (ASTM):
1. ASTM A48 – Gray Iron Castings.
2. ASTM C478 – Circular Precast Reinforced Concrete Manhole Sections.
3. ASTM C990 – Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
4. Minimum Sheet Size: 8-1/2″ x 11″.

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data.
2. Materials of construction.
3. Dimensioned Drawings.
4. Weights.
5. Conformance to referenced standards.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Section 03 30 00 – Cast-in-Place Concrete.

B. Precast Sections:
1. ASTM C478.
2. Minimum Wall Thickness: 4″.

C. Gaskets:
1. Description: Preformed flexible joint sealant.
2. Material: Butyl-rubber and / or refined hydrocarbons, resins, and plasticizing compounds.
3. Conformance: ASTM C990.

D. Access Covers:
   1. As indicated on the Drawings and specified or referenced herein.

E. Standard Ring and Cover:
   1. Material: Gray cast iron, ASTM A48 class 35 B.
   2. Duty: Heavy duty, rated for H-20 truck traffic.
   3. Clear Opening: 22″ minimum, or as indicated on Drawings.
   4. Vent: Vent opening.
   5. Pickhole: Open. OR Concealed. (Closed.)
   6. Ring Flange: Bottom flange for built-up type installation, top flange where slab style installation is shown on Drawings.
   7. Combined Ring and Cover Weight: 260 lb. minimum.
   8. Cover Pattern: Word "WATER" cast into center of cover.
   9. Seating: Covers to seat at all points on ring. Grind bearing surfaces to prevent rocking.

F. Embedded Aluminum Access Hatches:
   1. Aluminum construction in conformance with Section 05 50 00 – Metal Fabrications.
   2. Built-in neoprene gaskets.
   3. Spring-assisted, auto-locking stainless steel hold open arms.
   4. Minimum Clear Opening: As shown on Drawings.
   5. Frame and cover to be non-traffic rated.
   6. Installation as recommended by the manufacturer.

PART 3 EXECUTION

3.01 FABRICATION

A. Manhole Section:
   1. Precast.
   2. Minimum Inside Diameter.: 48″, or as indicated on Drawings or scheduled herein.
   3. Eccentric cones for manholes 6′ deep and greater.
   4. Flat, concrete manhole covers for manholes less than 6′ deep.
   5. Cones: Same or greater reinforcement and wall thickness as manhole section.
   6. Joints: Keylock type with preformed gaskets or mastic seal.
   7. Manhole Clear Opening: 22″ minimum, or as indicated on Drawings.

B. Manhole Height Adjustment:
   1. Use precast grade adjustment rings.
   2. 6″ maximum adjustment height above cone to bottom of ring and cover if manholes require steps.
   3. 12″ maximum adjustment height above cone to bottom of ring and cover if manholes do not require steps.

C. Placing Precast Manhole Sections:
   1. Clean ends of sections and apply cold bituminous mastic to both sections, or install preformed gasket.
   2. Completed manholes shall be rigid.

D. Preformed Gaskets:
   1. Manhole sections with chipped or cracked joints shall be rejected.
   2. Thoroughly clean section joints.
   3. Install gasket in conformance with manufacturer's recommendations.
   4. Only use primer furnished by gasket manufacturer.

E. Interior Manhole Finish – Precast Section:
   1. Remove excess mastic flush with precast sections.
   2. Mortar in joint openings flush with precast sections.
   3. Fill in any chipped areas.

F. Manhole Rings and Covers:
   1. Place rings in bed of mortar on top of manholes.
   2. Ensure no infiltration will enter manhole at this location.
   3. Carry mortar over flange of ring.
   4. Ring Wetting:
      a. Top to be flush with all surfaces subject to foot and vehicular traffic.
      b. Top to be 4″ above surfaces in open, untraveled areas or as shown on Drawings.

G. Embedded Aluminum Access Hatches:
   1. Hatches and other appurtenances cast into slab-style cover at precasting factory.

3.02 FIELD TESTING

A. Infiltration Testing:
   1. No visible running or dripping water.
   2. Repair all manholes that do not meet infiltration test.

3.03 SCHEDULE

A. As shown on Drawings.

END OF SECTION

SECTION 33 05 63

PRECAST CONCRETE WET WELLS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install round or rectangular precast concrete liquid-holding structures, either monolithic or sectional, as shown on the Drawings and as scheduled herein.

B. Access hatches or covers as specified herein.

1.02 WORK EXCLUDED

A. Manholes and other precast concrete structures not explicitly specified herein.

1.03 RELATED WORK

A. Section 03 30 00 – Cast-in-Place Concrete.

B. Section 09 97 01 – Industrial Coatings.

C. Section 33 05 63.01 – Precast Concrete Utility Structures.

1.04 REFERENCES

A. American Society for Testing and Materials International (ASTM):
1. ASTM A48 – Gray Iron Castings.
2. ASTM C207 – Hydrated Lime for Masonry Purposes.
3. ASTM C387 – Packaged Dry, Combined Materials for Mortar and Concrete.
4. ASTM C478 – Circular Precast Reinforced Concrete Manhole Sections.
5. ASTM C913 – Precast Concrete Water and Wastewater Structures.
6. ASTM C990 – Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.05 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data.
2. Plans and/or elevations locating and defining all materials furnished by manufacturer.
3. Conformance to referenced standards.
4. Dimensions, finishes, and weights.
5. Rated design loads, vertical and lateral.
6. Sections and details to indicate quantities and positions of reinforcing steel, anchors, inserts, etc.
7. Description of all loose, cast-in and field hardware.

8. Lifting and erection inserts.
9. Method of transportation and general job site requirements.

1.06 PRODUCT DESIGN CRITERIA

A. General: Design shall be in accordance with the applicable requirements of ASTM C418 or ASTM C913, as applicable.

B. Design Load Schedule:
1. Groundwater table at top of ground.
2. Snow Load: 50 psf.
3. Surface Live Load: 300 psf.

1.07 QUALITY ASSURANCE

A. Acceptable Manufacturers: Companies specializing in providing precast hydraulic structures and services normally associated with the industry for at least 5 years. When requested by the Engineer, submit written evidence to show experience, qualifications and adequacy of manufacturing capabilities for performance of Contract requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete:
1. Shall conform to the requirements indicated and/or referenced in ASTM C913.

B. Precast Sections:
1. ASTM C478 or ASTM C913, as applicable.
2. Minimum wall thickness: As scheduled or as shown on Drawings.

C. Hydrated Lime: ASTM C207, Type S.

D. Mortar: ASTM C387, or 1-part Portland Cement, 1/2-part hydrated lime, 3-parts sand.

E. Gaskets:
1. Preformed flexible joint sealant.
2. Material: Butyl-rubber and/or refined hydrocarbons, resins, and plasticizing compounds conforming to ASTM C990.

F. Castings:
1. Material: Gray cast iron, ASTM A48 Class 35B.

G. Access Covers: As indicated on the Drawings and specified or referenced herein.

PART 3 EXECUTION

3.01 FABRICATION

A. Structural Sections:
   1. Precast.
   2. Covers: Flat, concrete covers.
   3. Access openings: 22” minimum clear opening or as indicated on Drawings.
   4. Pipe penetrations:
      a. As indicated on the Drawings.
      b. Sealed with mechanical seals (watertight rubber links).

B. Embedded Aluminum Access Hatches:
   1. Aluminum construction in conformance with Section 43 25 13 – Submersible Sewage Pumps.
   2. Built in neoprene gaskets.
   3. Spring-assisted, auto-locking stainless steel hold open arms.
   4. Minimum clear opening: As shown on Drawings.
   5. Frame and cover to be non-traffic rated.
   6. Installation as recommended by the manufacturer.

3.02 ERECTION

A. Installation of precast concrete shall be performed by the manufacturer or an approved erector. Members shall be lifted by means of suitable lifting devices at points provided by the manufacturer. Temporary shoring and bracing, if necessary, shall comply with manufacturer’s recommendations.

B. Members shall be properly aligned and leveled as required by the Shop Drawings.

C. Placing Precast Sections:
   1. Clean ends of sections and apply cold bituminous mastic to both sections, or install preformed gasket.
   2. Completed structures shall be rigid.
   3. Completed structures shall be watertight to the extent that they shall meet both the exfiltration and infiltration tests specified herein.

D. Preformed Gaskets:
   1. Structure sections with chipped or cracked joints will be rejected.
   2. Thoroughly clean section joints.
   3. Install gasket in conformance with manufacturer’s recommendations.
   4. Only use primer furnished by gasket manufacturer.

E. Interior Structure Finish – Precast Sections:
   1. Remove excess mastic flush with precast sections.
   2. Mortar in joint openings flush with precast sections.
   3. Fill in any chipped areas with mortar.
   4. Fill in all lifting hook recesses with mortar.

F. Exterior Structure Finish – Precast Sections:
1. Cut any exposed steel lifting hooks to 1/4" below surface of precast section and cover exposed steel with grout. Stainless hooks may remain in place unless they create a trip hazard.

G. Interior Coating for Corrosion Protection:
1. Apply a C2 coating per Section 09 97 01 – Industrial Coatings.
2. Perform Holiday Test per Section 09 97 01 – Industrial Coatings.

H. Exterior Coating:
1. Dampproofing Coating C6 per Section 09 97 01 – Industrial Coatings.

I. Pipe Joints:
1. Provide joint in rigid pipe within 2' of structure.
2. Seal pipe penetrations through walls using mechanical gaskets (watertight rubber links).

3.03 FIELD TESTING

A. Leakage Testing: Test all precast concrete utility structures subject to internal hydrostatic loads by hydrostatic testing, unless directed otherwise by Engineer.
1. Hydrostatic Testing:
   a. Plug all inlets and outlets.
   b. Fill structure to 3/4 height.
   c. Allow water to stand for 24 hours.
   d. Leakage tested during following 24-hour period.
   e. Leakage: Less than 0.2 gph/ft above floor.
   f. Repair and retest all structures that do not meet leakage test.

B. Infiltration Testing:
1. No visible running or dripping water.
2. Repair all structures that do not meet infiltration testing.

3.04 SCHEDULE

A. New Abajo Lift Station Wet Well.
1. Diameter and Depth: As shown on Drawings.

END OF SECTION

SECTION 33 05 63.01

PRECAST CONCRETE UTILITY STRUCTURES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install buried rectangular precast concrete utility vaults either monolithic or sectional, as shown on the Drawings and as scheduled herein.

1.02 WORK EXCLUDED

A. Manholes and other precast concrete structures not explicitly specified herein.

1.03 RELATED WORK

A. Section 03 30 00 – Cast-in-Place Concrete.

B. Section 09 97 01 – Industrial Coatings.

1.04 REFERENCES

A. American Society for Testing and Materials International (ASTM):
   1. ASTM A48 – Gray Iron Castings.
   2. ASTM C990 – Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. ASTM C858 – Underground Precast Concrete Utility Structures.

1.05 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
   1. Product data.
   2. Plans and/or elevations locating and defining all materials furnished by manufacturer.
   3. Conformance to referenced standards.
   4. Dimensions, finishes, and weights.
   5. Rated design loads, vertical and lateral.
   6. Sections and details to indicate quantities and positions of reinforcing steel, anchors, inserts, etc.
   7. Description of all loose, cast-in and field hardware.
   8. Lifting and erection inserts.
   9. Method of transportation and general job site requirements.

1.06 PRODUCT DESIGN CRITERIA

A. General: Design shall be in accordance with the applicable requirements of ASTM C858.

B. Design Load Schedule:
1. Groundwater table at top of ground.
2. Snow Load: 50 psf.
3. Surface Live Load: 300 psf.

1.07 QUALITY ASSURANCE

A. Acceptable Manufacturers: Companies specializing in providing precast hydraulic structures and services normally associated with the industry for at least 5 years. When requested by the Engineer, submit written evidence to show experience, qualifications and adequacy of manufacturing capabilities for performance of Contract requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete:
1. Shall conform to the requirements indicated and/or referenced in ASTM C858.

B. Precast Sections:
1. ASTM C858.
2. Minimum wall thickness: As scheduled or as shown on Drawings.

C. Gaskets:
1. Preformed flexible joint sealant.
2. Material: Butyl-rubber and/or refined hydrocarbons, resins, and plasticizing compounds conforming to ASTM C990.

D. Castings:
1. Material: Gray cast iron, ASTM A48 Class 35B.

E. Access Covers: As indicated on the Drawings and specified or referenced herein.

PART 3 EXECUTION

3.01 FABRICATION

A. Structural Sections:
1. Precast.
2. Covers: Flat, concrete covers.
3. Access openings: 22 inch minimum clear opening.

4. Pipe penetrations:
    a. As indicated on the Drawings.
    b. Sealed with mechanical seals (watertight rubber links).

B. Embedded Cast-Iron Access Frames and Covers:
1. Slab-style castings as shown on the Drawings.
2. Frame and cover to be traffic rated.
3. Vented covers.

C. Embedded Aluminum Access Hatches:
1. Aluminum construction in conformance with Section 43 25 13 – Submersible Sewage Pumps.
2. Built-in neoprene gaskets.
3. Spring-assisted, auto-locking stainless steel hold-open arms.
4. Minimum clear opening: As shown on Drawings.
5. Frame and cover to be traffic rated.
6. Installation as recommended by the manufacturer.

3.02 ERECTION

A. Installation of precast concrete shall be performed by the manufacturer or an approved erector. Members shall be lifted by means of suitable lifting devices at points provided by the manufacturer. Temporary shoring and bracing, if necessary, shall comply with manufacturer's recommendations.

B. Members shall be properly aligned and leveled as required by the Shop Drawings.

C. Placing Precast Sections:
1. Clean ends of sections and apply cold bituminous mastic to both sections, or install preformed gasket.
2. Completed structures shall be rigid.

D. Preformed Gaskets:
1. Structure sections with chipped or cracked joints will be rejected.
2. Thoroughly clean section joints.
3. Install gasket in conformance with manufacturer's recommendations.
4. Only use primer furnished by gasket manufacturer.

E. Interior Structure Finish – Precast Sections:
1. Remove excess mastic flush with precast sections.
2. Fill in any chipped areas with grout.
3. Fill in all lifting hook recesses with grout.

F. Exterior Structure Finish – Precast Sections:
1. Cut any exposed steel lifting hooks to 1/4-inch below surface of precast section and cover exposed steel with grout. Stainless hooks may remain in place unless they create a trip hazard.

G. Exterior Coating:
   1. Dampproofing Coating C6 per Section 09 97 01 – Industrial Coatings.

H. Surface-Mounted Cast-Iron Access Frames and Covers:
   1. Place frames on top of structure with mastic seal.
   2. Place mortar over flange of frame.
   3. Ensure no infiltration will enter structure at this location.
   4. Cover to be 4 inches above surface.
   5. Frame and cover to be non-traffic rated.
   6. Vented covers.

3.03 FIELD TESTING

A. Infiltration Testing:
   1. No visible running or dripping water.
   2. Repair all structures that do not meet infiltration testing.

3.04 SCHEDULE

A. Wastewater Combination Air Valve Station Vault Sta. 42+98.

B. Wastewater Combination Air Valve Station Vault Sta. 50+50.

C. Abajo Lift Station Valve Vault.

D. Abajo Lift Station Discharge Magnetic Flow Meter Vault.

END OF SECTION

SECTION 33 31 01

SANITARY SEWERAGE SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewerage piping, non-pressure, non-surcharged, drain lines, sewer service lines, fittings, and accessories.

1.02 WORK EXCLUDED

A. Restrained joint ductile iron pipe used in gravity sewer jack and bore crossing details. Pipe is specified in Sections 33 05 23.01 – Jacking and Boring.

1.03 RELATED WORK

A. Section 31 23 33 – Trenching and Backfilling.

B. Section 33 05 23.01 – Jacking and Boring.

C. Section 33 05 61 – Sanitary Sewerage Manholes, Frames, and Covers.

1.04 GENERAL REQUIREMENTS

A. Pipes, fittings, and materials to be new.

B. Use appropriate equipment methods for unloading, reloading, and handling the pipe.

C. Pipe, Fittings, and Appurtenances of the Same Type: Made by the same manufacturer.

D. Provide labor, equipment and materials for field pipe testing.

1.05 QUALITY ASSURANCE

A. Ductile Iron Pipe and Fittings:
   1. Tests:
      a. ASTM E8: Tension Testing of Metallic Materials.
      b. ASTM E23: Impact Test.
   2. Marking: Cast on each pipe length.
      a. Weight, class, nominal thickness, and casting period.
      b. Manufacturer’s name, year of production, and letters “DI” or “Ductile Iron.”

B. PVC Pipe and Fittings:
   1. Tests: ASTM D2665, ASTM D3034, and ASTM F79, as applicable.
   2. Marking: Indelible, in each pipe.
      a. Nominal pipe diameter and cell classification.

b. Manufacturer's name or trade name, PVC, ASTM and SDR designation, and date of production.
c. Service designation.

1.06 REFERENCES

A. American Society for Testing and Materials International:
1. ASTM A536 – Ductile Iron Castings.
2. ASTM A746 – Ductile Iron Gravity Sewer Pipe.
3. ASTM C76 – Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. ASTM C443 – Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
5. ASTM D395 – Rubber Property – Compaction Set.
6. ASTM D412 – Vulcanized Rubber and Thermoplastic Elastomer - Tension.
7. ASTM D882 – Tensile Properties of Thin Plastic Sheeting.
8. ASTM D1784 – Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
9. ASTM D2321 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
10. ASTM D2412 – Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
11. ASTM D2564 – Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
12. ASTM D2665 – Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
13. ASTM D3034 – Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
14. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
15. ASTM D3311 – Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
16. ASTM D4976 – Polyethylene Plastics Molding and Extrusion Materials.
17. ASTM F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
18. ASTM F679 – Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
19. ASTM F794 – Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe And Fittings Based On Controlled Inside Diameter.
20. ASTM F894 – Polyethylene (PE) Large Diameter Profile Wall Sewer And Drain Pipe.
21. ASTM F1417 – Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air.
22. ASTM F1668 – Procedures for Buried Plastic Pipe.
23. ASTM F1803 – Poly(Vinyl Chloride) (PVC) Closed Profile Gravity Pipe And Fittings Based On Controlled Inside Diameter.
24. ASTM F1866 – Poly(Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings.

B. American Water Works Association:
1. ANSI/AWWA C104/A21.4 – Cement Mortar Lining for Ductile-Iron Pipe and Fittings.

2. ANSI/AWWA C105/A21.5 – Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. ANSI/AWWA C110/A21.10 – Ductile-Iron and Gray Iron Fittings.
4. ANSI/AWWA C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. ANSI/AWWA C116/A21.16 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Flirtings.
6. ANSI/AWWA C153/A21.53 – Ductile-Iron Compact Fittings.
7. ANSI/AWWA C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe.
8. ANSI/AWWA C302 – Reinforced Concrete Pressure Pipe, Noncylinder Type.
9. ANSI/AWWA C605 – Underground Installation of Poly(Vinyl Chloride) (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
10. AWWA Manual M23 – PVC Pipe – Design and Installation.

C. PVC Pipe Association (Uni-Bell PVC Pipe Association):
1. UNI-B-06 – Recommended Low-Pressure Air Testing of Installed Sewer Pipe.

1.07 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data for pipe and appurtenances.
2. Manufacturer's installation instructions.
3. Certifications showing conformance to standards specified herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. PVC Non-Pressure Pipe:
1. Pipe and Fittings:
a. 18″ and Larger: Solid wall, ASTM F679, SDR 35 (Pipe Stiffness PS 46 psi in accordance with ASTM D2412).
b. 4″ to 15″: Solid wall, ASTM D3034, SDR 35 (Pipe Stiffness PS 46 psi in accordance with ASTM D2412).
c. PVC plastic minimum cell classification per ASTM D1784: 12454 or 12364.
d. Laying Length: Standard 20′ or 14′.
2. Joints:
a. Internally cast bell with one sealing ring.
b. Leak-Proof, Rubber Rings: ASTM D3212 and F477.
c. Lubricant: Manufacturer's recommendations.

B. Service Wye/Tee: In-line connections required unless not available as an industry standard for a particular size of line.

C. Pipe Marking Systems: Refer to Section 31 23 33 – Trenching and Backfilling.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE

A. General:
1. Install as indicated on Drawings.
2. Trenching, Backfilling, and Compacting: Section 31 23 33 – Trenching and Backfilling.
3. Pipe Cutting: Measurement taken at site.
4. Handling and Installation: ASTM D2321, AWWA C605, and manufacturer's recommendations.
5. Securely close the end of the pipe at the end of each day or whenever the work ceases with a watertight seal.
6. Take precautions necessary to prevent uplift and floating of the pipe prior to backfilling.

B. Delivery, Handling, and Storage of PVC Pipe:
1. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Engineer.
2. Inspect each pipe shipment prior to unloading to see if the load has shifted or otherwise been damaged. Notify Engineer immediately if more than immaterial damage is found. Check each pipe shipment for quantity and proper pipe size, color, and type.
3. Off-load and handle pipe in accordance with AWWA M23 and AWWA C605, and all of the Pipe Supplier's guidelines.
4. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
5. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
6. Lower pipe from trucks carefully. Do not drop pipe.
7. Mark as rejected and remove at once from the work any pipe showing a crack or which has received a blow that could have caused an incident fracture, even though no such fracture can be seen.
8. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and shall be rejected unless determined acceptable by the Engineer.
9. Store and place pipe lengths on level ground. Store pipe at the job site in the unit packaging provided by the Pipe Supplier. Exercise caution to avoid compression, damage, or deformation to the ends of the pipe. Keep the interior of the pipe, as well as all end surfaces, free from dirt and foreign matter.
10. Handle and support pipe using woven fiber pipe slings or approved equivalent. Exercise care when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way.
11. If pipe is to be stored for periods longer than 90 days, the pipe and gaskets should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe shall be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
12. Store and stack pipe in accordance with the Pipe Supplier's guidelines.

C. PVC Pipe Joint Assembly:
   1. Conformance to ASTM D2321 and manufacturer's instructions.
   2. Pipe spigot ends are pre-marked at the factory with a circumferential insertion line. This line references how far the spigot should be inserted into the adjoining PVC pipe bell. Field-cut spigot ends shall be marked and beveled to match the manufacturer's insertion line. Pipe-to-pipe joints shall be assembled only to the insertion line. After assembly, the insertion line shall remain visible and be nearly flush with the lip of the adjoining PVC pipe bell. Joints assembled beyond the insertion line shall be considered over-assembled and may result in damaging stresses or leakage.
   3. Field Quality Control to Prevent Over-Assembly (Over-Insertion):
      a. If a joint is found to be over-inserted, Contractor shall expose previously assembled joints until properly assembled joints are found. All over-inserted joints shall be properly re-assembled.

D. Use rigid rubber gasket on exterior of pipe to seal pipe into grout at manholes.

E. Clean sewer lines of all sand, gravel, dirt, and other foreign materials after installation.

F. Service Lines as indicated on Drawings:
   1. Locations generally determined by Owner or Engineer at time of construction.
   2. Service lines to extend to the edge of the right-of-way or to the edge of the permanent easement.

3.02 FIELD QUALITY CONTROL

A. All gravity pipes shall be tested for exfiltration and/or infiltration and deflection, as specified. All pipe shall be backfilled prior to testing. All leakage tests shall be completed and approved prior to placing of permanent resurfacing. When leakage or infiltration exceeds the allowable amount, the Contractor at its expense, shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

B. Leakage Tests: Performed as scheduled, but no less than on 25% of the reaches of sewer between manholes as selected by the Engineer. Reaches not passing leakage test are not counted initially or when retested in determining percent of reaches tested. Test as follows:
   1. Gravity pipelines 24″ or less in diameter, where difference in elevation between inverts of adjacent manholes or structures is 10′ or less; water exfiltration test or water infiltration test as approved. The Engineer may allow substitution of an air pressure test for the water exfiltration test.
   2. Gravity pipelines 24″ or less in diameter, where difference in elevation between inverts of adjacent manholes or structures is greater than 10′; air pressure test or water exfiltration test, or as approved.
   3. Gravity pipelines greater than 24″ in diameter; air pressure test.
   4. Methods used, scheduling, and duration of tests must be reviewed by Engineer.

C. Water Exfiltration Test:
   1. Contractor to provide the water supply and all required materials and equipment.
   2. Block off all manhole openings except those connecting with the reach under test.
   3. At the upper ends, fill the line a minimum depth of 5′ above the high point of the pipe or 5′ above adjacent groundwater level, whichever is higher.
   4. Add and measure water as required to maintain a constant level.
      a. Maximum exfiltration: 100 gallons per day per inch nominal diameter per mile of pipe.
      b. Manholes considered section of 48″ pipe.
      c. Testing period shall last 4 hours.

D. Water Infiltration Test:
   1. If, in the opinion of the Engineer, excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test for leakage shall not be used and an infiltration test shall be used.
   2. Block off the upper end of the reach to be tested.
   3. Discontinue pumping of groundwater for at least 3 days after which the section shall be tested for infiltration.
   4. The infiltration into each individual reach of sewer between adjoining manholes shall not exceed 100 gallons per day per inch of nominal diameter per mile of pipe.
   5. Testing period shall last 4 hours.
   6. Unless otherwise specified, infiltration shall be measured by the Contractor using measuring devices reviewed by the Engineer.

E. Air Pressure Test:
   1. Safety Procedures: Follow jobsite safety procedures described in ASTM F1417, Section 6, including:
      a. No one shall be allowed in the manholes during testing.
      b. When lines are tested, it is mandatory that all the caps and plugs be braced as an added safety factor.
      c. A regulator or relief valve set no higher than 9 psi shall be included on all pressurizing equipment.
   2. Block off all manhole and line openings.
   3. Introduce low pressure air into the plugged line until the internal line pressure is raised to approximately 4.0 psi.
   4. Test pressures shall not exceed 9 psi.
   5. After the internal line pressure has stabilized at or above 3.5 psi, start the test.
   6. The line is presumed to have failed the test if the pressure drop exceeds 0.5 psi during the specified test duration.
   7. Run the test for the time duration determined by the equations and procedures contained in Uni-Bell Standard UNI-B-6 – Recommended Practice for Low Pressure Air Testing of Installed Sewer Pipe. For convenience, the table at the end of this section is from Uni-Bell Standard UNI-B-6 for the 0.5 psi pressure drop procedure (Table II).
   8. For pipe sizes not given in the table, refer to Uni-Bell Standard UNI-B-6.

F. Mandrel Test:
1. Performed on all lines made from plastic resin.
2. No sooner than 30 days after placement and compaction of backfill, but prior to placement of permanent surface materials.
3. Use a rigid mandrel with diameter of at least 92.5% of the pipe's specified average inside diameter and a length of the mandrel circular portion at least equal to the nominal pipe diameter.
4. Pull the mandrel through the pipe by hand.
5. All pipe exceeding the 7.5% deflection shall be relaid or replaced by the Contractor at no additional cost to the Owner.

G. Television Inspection:
1. Required for all gravity sewers unless scheduled otherwise.
2. Scheduling of Inspection: Perform inspection after sewer pipe has been cleaned, flushed, and all debris and plugs have been removed. Perform successful inspection as a condition of substantial completion.
3. Notification of Inspection: Notify Owner and Engineer 7 calendar days prior to performing the inspection and allow Owner and Engineer to be present to observe the inspection.
4. Television Equipment: Camera shall be color, equipped with rotating lens capable of 360-degree rotation with zoom focus and a wide-angle lens permitting spontaneous focal adjustments that allow viewing of service laterals connections, joints, pipe walls, and other installation anomalies.
5. Inspection Log: Maintain a television inspection report log during the inspection. Indicate project, general location, each manhole-to-manhole segment and stationing, pipe material and size, description of any trenchless rehabilitation repairs, stations and positions of all live taps and stub-outs, limits of any sags, and any abnormal or line defects within each segment. Submit completed logs and video files to the Owner and Engineer.
6. Perform television inspection of needed line repairs and re-inspections when the previous inspection is not satisfactory to the Owner and Engineer.
7. Submission: Submit completed logs and video recording files to the Owner and Engineer in a format acceptable to the Owner and Engineer.

H. Grade Tolerances:
1. Free from noticeable depressions or humps.
2. Invert elevations shall not exceed ±0.2′ from elevations shown on Drawings or which can be computed from Drawings.
3. Shall comply with the lesser of the following:
   a. not more than 0.1% difference from grade shown on Drawings.
   b. not more than 10% of grade shown on Drawings.

3.03 SCHEDULE

A. As indicated on Drawings.

MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015 cf/min/sf of surface

Pipe Diameter (in)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:54	57	20.942 L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04
48	22:47	50	27.352 L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09
54	25:31	44	34.618 L	57:42	86:33	115:24	144:15	173:05	201:56	230:47	259:38
60	28:20	40	42.738 L	71:14	106:51	142:28	178:05	213:41	249:18	284:55	320:32

Note: If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete. (See Section 7.5.)

END OF SECTION

SECTION 40 27 00

PROCESS PIPE SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Pipes, materials, and appurtenances for all buried and exposed treatment plant, lift station, process, pump station, and sewage force main piping and similar facilities.

B. Installation of necessary valves and accessories.

C. Pipe anchors and supports.

D. Pipe insulation.

1.02 GENERAL REQUIREMENTS

A. Pipes, Fittings, and Materials to be New.

B. Use Appropriate Equipment Methods for Unloading, Reloading, and Handling the Pipe.

C. Pipe, Fittings, and Appurtenances of the Same Type: Made by the same manufacturer.

D. Provide Labor, Equipment and Materials for Field Pipe Testing.

E. All interior valves to have flange connections except where otherwise indicated.

1.03 REFERENCES

A. American Society for Testing and Materials International (ASTM):
1. ASTM A153 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A183 – Carbon Steel Track Bolts and Nuts.
3. ASTM A307 – Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
4. ASTM A536 – Ductile Iron Castings.
5. ASTM B633 – Electrodeposited Coatings of Zinc on Iron and Steel.
6. ASTM C335 – Steady-State Heat Transfer Properties of Pipe Insulation.
7. ASTM C356 – Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat.
8. ASTM C411 – Hot-Surface Performance of High-Temperature Thermal Insulation.
9. ASTM C547 – Mineral Fiber Pipe Insulation.
10. ASTM C553 – Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

11. ASTM C585 – Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
12. ASTM D1784 – Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
13. ASTM D1785 – Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
14. ASTM D2241 – Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
15. ASTM D2464 – Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM D2466 – Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
17. ASTM D2467 – Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
18. ASTM D2564 – Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
19. ASTM D2672 – Joints for IPS PVC Pipe Using Solvent Cement.
20. ASTM D3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
21. ASTM D3350 – Polyethylene Plastics Pipe and Fittings Materials.
22. ASTM E8 – Tension Testing of Metallic Materials.
23. ASTM E23 – Notched Bar Impact Testing of Metallic Materials.
24. ASTM E84 – Surface Burning Characteristics of Building Materials.
25. ASTM F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. ASTM F714 – Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
27. ASTM F2206 – Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock.
28. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

B. American Water Works Association (AWWA):
1. ANSI/AWWA C104/A21.4 – Cement Mortar Lining for Ductile-Iron Pipe and Fittings.
2. ANSI/AWWA C105/A21.5 – Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. ANSI/AWWA C110/A21.10 – Ductile-Iron and Gray-Iron Fittings.
4. ANSI/AWWA C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. ANSI/AWWA C115/A21.15 – Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. ANSI/AWWA C116/A21.16 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fitrtings.
7. ANSI/AWWA C151/A21.51 – Ductile-Iron Pipe, Centrifugally Cast.
8. ANSI/AWWA C153/A21.53 – Ductile-Iron Compact Fittings.
9. AWWA C200 – Steel Water Pipe-6 In. (150 mm) and Larger.
10. AWWA C203 – Coal-Tar Protective Coatings and Linings for Steel Water Pipe.
11. AWWA C207 – Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
12. ANSI/AWWA C208 – Dimensions for Fabricated Steel Water Pipe Fittings.

13. ANSI/AWWA C209 – Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings.
14. ANSI/AWWA C213 – Fusion-Bonded Epoxy Coating for the Interior of Steel Water Pipelines.
15. ANSI/AWWA C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe.
16. ANSI/AWWA C228 – Stainless-Steel Pipe Flange Joints for Water Service, Sizes 2 In. Through 72 In. (50 mm Through 1,800 mm).
17. ANSI/AWWA C600 – Installation of Ductile-Iron Mains and Their Appurtenances.
18. ANSI/AWWA C604 – Installation of Buried Steel Water Pipe, 4-In. (100mm) and Larger.
19. ANSI/AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
20. ANSI/AWWA C606 – Grooved and Shouldered Joints.
21. ANSI/AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm), for Water Transmission and Distribution.
22. ANSI/AWWA C906 – Polyethylene (PR) Pressure Pipe and Fittings, 4-In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks.
23. AWWA Manual M23 – PVC Pipe – Design and Installation.
24. AWWA Manual M55 – PE Pipe – Design and Installation.

C. National Sanitation Foundation International (NSF):
1. NSF/ANSI 61 – Drinking Water System Components – Health Effects.
2. NSF/ANSI 372 – Drinking Water System Components – Lead Content.

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product Data for pipe materials, including pipe size, dimensions, pressure class, restraint devices, and appurtenances.
2. Manufacturer's installation instructions.
3. Layout Drawings for DIP furnished with ring-type integral buried joint restraint.
4. Layout Drawings for pipe furnished with grooved and shouldered joints showing locations of rigid and flex style joints.
5. Non-Toxic and Lead-Free Certification: Written statement that all materials in contact with potable water or raw water supply shall be NSF/ANSI 61 compliant, and shall be lead-free, as certified by the Water Quality Association to comply with NSF/ANSI 372.

1.05 QUALITY ASSURANCE

A. Ductile Iron Pipe and Fittings:
1. Tests:
   a. ASTM E8: Tension Testing of Metallic Materials.
   b. ASTM E23: Impact Test.
2. Marking: Cast on each pipe length.
3. Weight, class, nominal thickness, and casting period.

4. Manufacturer’s name, year of production, and letters “DI” or “Ductile Iron.”

B. Tests for Steel Pipe and Fittings: ASTM A90, ASTM A370.

C. PVC Pipe and Fittings:
1. Tests: ASTM D3034, ANSI/AWWA C900, ASTM D1784, and ASTM D1785, as applicable.
2. Marking: Indelible, in each pipe.
   a. Nominal pipe diameter and cell classification.
   b. Manufacturer’s name or trade name, PVC, ASTM and SDR designation, AWWA pressure class, and date of production.
   c. Service designation.

D. High Density Polyethylene (HDPE):
1. Tests: ASTM D3035, ANSI/AWWA C906, AWWA Manual M55, PPI Handbook of Polyethylene Pipe.
2. Marking: indelible, each pipe.
   a. Nominal pipe size and material designation.
   b. Manufacturer’s name or trade name, HDPE, ASTM and DR designation, and date of production.
3. Gasket Rings: Marked with the manufacturer’s identification, size, year of production, and classes of pipe in which they are to be used.
4. Fusion: ASTM F2620.

PART 2 PRODUCTS

2.01 MATERIALS AND FABRICATION

A. Ductile Iron:
1. Pipe:
   a. ANSI/AWWA C151/A21.51: ASTM A536, Grade 60-42-10.
   b. Thickness: Pressure Class 350 for pipes 12" diameter or smaller; Pressure Class 250 for pipes 14" diameter or larger unless otherwise scheduled.
2. Fittings: Cast from ductile iron: ANSI/AWWA C110/A21.10 full body or ANSI/AWWA C153/A21.53 short body.
3. Joints: ANSI/AWWA C111/A21.11:
   a. Mechanical Joint: 350 psi working pressure.
   b. Flange: Also ANSI/AWWA C115/A21.15 and ANSI/ASME B16.42, ductile iron; 150 lb. pattern, unless scheduled otherwise.
   c. Bolts, Tie Bolts, and Nuts:
      1) Low carbon steel, ASTM A307.
      2) Bolts smaller than 3/4": With heavy hex heads for flange and T-head for MJ, and heavy hex nuts.
      3) Bolts 3/4" and larger: With hex heads for flange and T-heads for MJ, and heavy hex nuts.
      4) Coating, Exposed Service: Grade B zinc coat per ASTM A153.
      5) Coating, Buried Service: Liquid applied fluoropolymer coating matrix consisting of lubricating compounds, UV stabilizers and coloring agents or pigments, heat cured, 0.7 to 1.0 mil total DFT.

d. Gaskets for mechanical joints, push-on and flanged joints:
    1) Conformance: ANSI/AWWA C111/A21.11.
    2) Material: Synthetic rubber as specified in referenced standard. Natural or reclaimed rubber not acceptable.
    3) High Temperature Air Service Piping: Viton rubber rated for 350°F.
e. Lubricant: In conformance with ANSI/AWWA C111/A21.11.

4. Joint Restraint: Furnish external mechanical restraint devices, including restrained flange adaptors for exposed piping as specified herein, or integral joint restraints for buried joints if specified herein. Furnish restraint devices where scheduled or noted on Drawings, as specified in Part 2 of this Specification.
    a. Integral Buried Joint Restraint:
        1) Minimum Pressure Rating: 350 psi to 18", 250 psi to 24", 150 psi to 30".
        2) Gasket Type: U.S. Pipe Field Lok 350® Gasket, American Ductile Iron Pipe Fast-Grip® Gasket, or Engineer reviewed equivalent.
        3) Ring Type: U.S. Pipe TR FLEX® Joint, American Ductile Iron Pipe Flex-Ring® Joint, American Ductile Iron Pipe Lok-Ring® Joint, or Engineer reviewed equivalent.
            a) For gasket-type integral restraint:
            Pipe manufacturer shall furnish to Contractor two (2) feeler gages capable of determining depth of gasket and presence of metal locking segments.
            b) Contractor shall wrap bell of each restrained joint with factory furnished tape with words “Restrained Joint.”
            c) Pipe manufacturer shall furnish to Contractor two (2) complete kits of extractor shims and shim holders (slotted and curved steel block used to drive the shims with a hammer) for each size of pipe used.
5. Thickness: Pressure Class 350 for pipes 4-12" and Pressure Class 250 for pipes ≥ 14" unless otherwise scheduled.
6. Corrosion Protection:
    a. Outside Coating (buried or submerged service):
        1) Pipe: Bituminous per ANSI/AWWA C151/A21.51.
        2) Fittings: Bituminous per ANSI/AWWA C110/A21.10 and ANSI/AWWA C153/A21.53 or fusion-bonded epoxy per ANSI/AWWA C116/A21.16.
    b. Outside Coating, Exposed Service (not submerged): Prepare surface with SSPC-SP6-commercial blast cleaning and shop coat with rust inhibiting modified alkyd shop primer equivalent to Tnemec Series 4 Versare Primer or Sherwin-Williams Kem Kromik Universal Metal Primer. Field coat in accordance with Section 09 97 01 – Industrial Coatings, Service Conditions F8, unless scheduled otherwise.

c. Outside Coating, Exposed Service (submerged): Prepare surface with SSPC-SP10-near-white blast cleaning and shop coat with rust inhibiting modified alkyd shop primer equivalent to Tnemec Series 4 Versare Primer or Sherwin-Williams Kem Kromik Universal Metal Primer. Field coat in accordance with Section 09 97 01 – Industrial Coatings, Service Conditions F1, unless scheduled otherwise.

d. Inside Coating, Process Liquid Service: Cement mortar lining with bituminous seal coat, ANSI/AWWA C104/A21.4, unless scheduled otherwise.

e. Inside Coating, Process Air Service: Epoxy lining, two coats, 24 mil minimum total dry film thickness.

f. Glass Lining for inside coating when scheduled or shown on Drawings: Porcelain enamel coating, 10-15 mils total thickness, applied in 2 layers to substrate which has been blasted to white metal condition per SSPC-SP5; coating material fired at nominal oven temperature of 1400 Fº.

g. Inside Coating: Ceramic epoxy lining for inside coating when scheduled or shown on Drawings:
   1) Epoxy Material: Factory-installed amine cured novalac epoxy, minimum 20% by volume ceramic quartz pigment.
   2) Applied to pipe prepared by abrasive blast cleaning at coating factory.
   3) Applied to pipe interior, 6" of spigot end exterior and gasket socket.
   4) 40 mil nominal thickness, 6 mils nominal thickness at spigot ends and gasket sockets.
   5) Successfully pass nondestructive 2,500 volt holiday test.
   6) Acceptable Manufacturer: Protecto 401 by Induron Coatings, (205) 324-9584, or Engineer reviewed equivalent.

h. Polyethylene Encasement:
   1) Conformance: ANSI/AWWA C105/A21.5.
   2) Material: ASTM D4976, Group 2.
   3) Configuration: Seamless tube or sheet.
   4) Film Requirements:
      a) Linear Low-density Polyethylene:
         i. Thickness: 8 mil.
         ii. Density: 0.910 to 0.935 g/cm^3.
         iii. Tensile Strength: 3,600 psi for 8 mil, ASTM D 882.
      b) High-density, Cross-laminated Polyethylene:
         i. Thickness: 4 mil.
         ii. Density: 0.940 to 0.960 g/cm^3.
         iii. Tensile Strength: 6,300 psi for 4 mil, ASTM D 882.
   5) Color: Weather-resistant black containing not less than 2 percent carbon black.
   6) Pipe Wrap Tape:
      a) Material: 10 mil all weather polyvinyl film.
      b) Durability: Resistant to moisture and corrosive soil.
      c) Adhesion: Adheres to metal and plastic, and conforms to irregularities in substrate surfaces.
      d) Elongation: 245 percent.
      e) Tensile Strength: 30 psi.

f) Width: 2".
g) Printed Identification Marking: UPC code and mil thickness.
h) Acceptable Manufacturer: Northtown Company, or Engineer reviewed equivalent.

7) Strapping: Non-metallic, water-resistant FS PPP-S-760.
8) Install on buried ductile iron piping, fittings, and restraint assemblies in accordance with AWWA C105, unless scheduled otherwise.

B. Steel:
1. Pipe:
a. 6" and larger: AWWA C200; Minimum wall thickness: 0.25" unless otherwise scheduled.
b. 5" and smaller:
1) ASTM A53 for gas service (unless specified otherwise in Division 15) and all other uses.
2) Or as scheduled.
2. Flanges and Flange Hardware: AWWA C207.
a. Bolts to be hexagonal head.
b. Bolts and nuts to be zinc coated per ASTM A153.
c. Gaskets as specified in AWWA C207 except gaskets on air service lines to be red silicone rubber.
3. Fittings: ANSI/AWWA C208.
4. Corrosion Protection:
a. Outside Coating, 6" and Larger, Buried Service: SSPC-SP10 with 16 mils coal tar enamel per ANSI/AWWA C203.
b. Outside Coating, 5" and Smaller, Buried Service: Cold-Applied Tape Wrap:
1) Surface Preparation: SSPC SP-2 Hand Tool Cleaning.
2) Conformance Standard: NACE SP0109 (Cold-Applied Laminate Polymeric Tapes), and ANSI/AWWA C209 (Type II).
3) Thickness: 50 mils.
4) Primer: Integrated with Adhesive. Follow manufacturer's recommendations for using optional primer at low application temperatures.
5) Installation: Spiral wrap with minimum 1" overlap or 20% of the tape width, whichever is greater. Follow manufacturer's recommendations.
c. Outside Coating, Exposed Service: Section 09 97 01 – Industrial Coatings, Service Condition F3 unless otherwise scheduled at the end of this Section.
d. Inside Coating:
1) Potable water service: Contractor's choice of cement mortar lining or SSPC-SP10 blast with NSF 61-certified epoxy coating unless otherwise scheduled at the end of this Section.
2) Wastewater, storm water, and similar fluids: Section 09 97 01 – Industrial Coatings, Service Condition F1.

C. Galvanized Steel:
1. Pipe: ASTM A53, Grade B.
2. Fittings: Joints as shown on Drawings.
   a. Malleable Iron, threaded: ANSI B16.3.
   b. Steel Fittings, welded and flanged: ASTM A234.
   c. Flanges: AWWA C207, red rubber (SBR) gaskets.
   d. Malleable Iron, grooved and shouldered: ASTM A47.
3. Air Piping: Schedule 40 for 6" and smaller.
   a. Schedule 20 for 8" to 12".
   b. Schedule 10 for 14" and larger.
4. Corrosion Protection:
   a. Hot-Dip Process: ASTM B6 zinc inside and outside:
      1) Pipe: ASTM A123.
      2) Threaded fittings and flange bolts: ASTM A153.
   b. Weight of Coating: ASTM A90.
   c. Field Touch-up: After assembly, coat exposed threads and all other damage to factory zinc coatings with liquid-applied cold galvanizing compound in conformance with ASTM A780.

D. Polyvinyl Chloride (PVC):
1. Pipe and fittings:
   a. Pipe sizes 4" through 60":
      1) ANSI/AWWA C900.
      2) Pressure class as scheduled; Class 235 psi (DR 18) minimum if not scheduled otherwise.
      3) Fittings: Cast from ductile iron; ANSI/AWWA C110/A21.10, full body or ANSI/AWWA C153/A21.53, short body; mechanical joint ANSI/AWWA C111/A21.11, external mechanical restraint devices as specified herein. Encase fittings and all external restraint assemblies with polyethylene encasement per ANSI/AWWA C105/A21.5, unless scheduled otherwise.
   b. Pipe sizes 3.5" and smaller:
      1) Unless otherwise scheduled or shown on the Drawings.
         a) ASTM D2241.
         b) 1.5" and smaller: SDR 21.
         c) 2" through 3.5": SDR 26.
         d) Pressure rating as scheduled; 160 psi minimum if not scheduled.
      2) If scheduled or shown on the Drawings:
         a) Schedule 40 and 80 Pipe Dimensions and Workmanship: ASTM D1785.
         b) Schedule 40 minimum unless otherwise scheduled or shown on Drawings.
         c) Material: ASTM D1784, Class 12454-B.
         d) Fittings:
            i. ASTM D2466, Schedule 40.
            ii. ASTM D2464, Schedule 80, threaded.
            iii. ASTM D2467, Schedule 80, socket type.

2. Joints:
    a. Gasket Bell Ends: ASTM D3139, lubricant assembled.
    b. Gaskets: ASTM F477, elastomeric.
    c. Solvent Cement: ASTM D2564 only where specifically allowed by Engineer, schedules or Drawings.
    d. Solvent Cement Bell End: ASTM D2672.
3. Joint Restraint: Furnish external mechanical restraint devices, including restrained flange adaptors, as specified herein, or integral joint restraints for buried joints if specified herein. Furnish restraint devices where scheduled, noted on Drawings, and where specified in this specification.

E. High Density Polyethylene (HDPE) 3" to 54":
1. Conformance: AWWA C906, AWWA Manual M55, PPI Handbook of Polyethylene Pipe.
2. Resin: High density polyethylene (HDPE) PE4710 having minimum cell classification 445474C/E as rated by the Plastic Pipe Institute (PPI) and in conformance with ASTM D3350.
3. Wall Thickness Design: ASTM F714, DR pipe dimension ratio based on controlled outside diameter, DIPS sizing system.
    a. Unless scheduled otherwise, DR 11.
4. Joints: Thermal fusion ASTM F2620.
5. Bend Fittings: ASTM D2206 fabricated butt-fused polyethylene (ductile iron pipe size) and match DR of host pipe. 90-degree and 45-degree bends shall be three segment.
6. Connections to Other Piping and Valves: Fusion bonded HDPE Flange adapters with ductile iron back-up rings, ANSI B16.5 150 lb. flange pattern, or fusion bonded restrained MJ adapters.

F. External Mechanical Restraint Devices:
1. Works on principle of multiple wedging action against pipe, which increases its resistance as line pressure increases while maintaining joint flexibility. Set screw devices are not acceptable. Split non-serrated back-up rings behind bells are acceptable. Split serrated restraint rings are not acceptable, except on spigot end of bell restraint harness of C900 PVC pipe up to 12". EBAA Iron Sales, Inc. or Engineer reviewed equivalent.
2. Gland: Ductile iron with dimensions which match standard mechanical joint bells per ANSI/AWWA C153/A21.53, ASTM A536, Grade 65-45-12.
3. Wedges: Heat-treated ductile iron with minimum Brinnel hardness of 370 BHN.
4. Wedges tightened during installation via twist-off nuts.
5. Devices shall be designed for the following working pressure:
    a. 250 psi for 18" to 48" DIP, 2:1 safety factor.
    b. 350 psi for 3" to 16" DIP, 2:1 safety factor.
    c. Meets or exceeds standardized pressure rating of host PVC piping.
6. Devices shall be designed for the type of pipe material and pipe joint being harnessed.
7. An identification number shall be cast into each gland body with the following information: Date and shift of manufacture, and plant location.

8. All physical and chemical test results shall be made available to Engineer for review upon request by referencing the identification number.
9. Coating for wedges, wedge actuators, bolts, tie bolts, nuts, and related fastener and gripping components:
    a. Surface Preparation: Cleaner wash, phosphatizing, rinse, and drying.
    b. Coating: Liquid applied fluoropolymer-matrix consisting of lubricating compounds, UV stabilizers, and coloring agents or pigments. Heat cured. Two coats, 0.7 to 1.0 mil total DFT.
    c. Low VOC, resin bonded and thermally cured, single film, dry lubricant, primarily formulated for use on fasteners.
    d. Designed to prevent corrosion and facilitate make-up torque.
    e. Provide lubricity of coating for proper dispersion of PTFE.
10. Coating for Cast Bodies:
    a. Surface Preparation: Cleaner wash, phosphatizing, rinse, and drying.
    b. Coating: Electrostatically applied TGIC polyester-based powder. Heat cured. 1.5 to 4.0 mils total DFT.
    c. Designed to prevent corrosion, impact and UV resistance.
    d. Appearance: Class 5 (orange peel) PCI smoothness standard; 75% to 85% gloss at 60 degrees per ASTM D523; pinhole free.

G. Grooved and Shouldered Joints:
1. Conformance: ANSI/AWWA C606.
2. Rated Working Pressure: Not less than that specified for the pipe.
3. Application:
    a. Exposed and buried ductile iron pipe, 3" to 36", Class 53 or heavier, in lieu of flanged or mechanical joints and fittings.
    b. Exposed black or galvanized steel pipe, in lieu of flanged joints and fittings.
    c. Or where indicated on Drawings.
4. Mechanical Couplings:
    a. Design: Housing and gaskets shall be designed to fully seat and seal by visual verification without need to measure bolt torque.
    b. Groove: Cutting, rolling and dimensions in conformance with ANSI/AWWA C606.
    c. Rigid/Flex Style Joints: Locations as indicated on Drawings or as indicated on accepted Shop Drawings.
    d. Housing: Two or more segments of ductile iron, ASTM A536, grade 65-45-12.
    e. Housing Factory Coating:
        1) Exposed Service: 1.5 mil alkyd phenolic primer, enamel top coat.
        2) Buried or Immersion Service: Coal tar epoxy.
    f. Gaskets: Pressure-responsive synthetic rubber, grade as recommended by manufacturer as suitable to meet fluid and temperature requirements. All materials in contact with potable water shall be NSF 61 certified.
    g. Coupling Bolts and Nuts:
        1) Exposed Service: Heat treated carbon black steel per ASTM A183, 110,000 psi tensile strength, with zinc plating per ASTM B633.
        2) Buried or Immersion Service: Type 304 stainless steel.

5. Ductile Iron Fittings:
    a. Material: Ductile iron, ASTM A536, grade 65-45-12.
    b. Center-to-End Dimensions and Wall Thickness: Conform to ANSI/AWWA C110/A21.10.
    c. Rated Working Pressure:
        1) 3" to 12": 350 psi.
        2) 14" to 36": 250 psi.
    d. Grooved Ends: ANSI/AWWA C606.
    e. Factory Coating:
        1) Exposed Service: 1.5 mil alkyd phenolic primer, enamel top coat.
        2) Buried or Immersion Service: Coal tar epoxy.
        3) Lining: Cement mortar lining ANSI/AWWA C104/A21.4.
6. Connection to Adjacent Valves and Flanged Piping:
    a. Furnish valves with factory grooved ends conforming to ANSI/AWWA C606.
    b. Or furnish flange adapter with grooves conforming to ANSI/AWWA C606.
7. Acceptable Manufacturers: Victaulic Company or Engineer reviewed equivalent.
8. Installation: Follow manufacturer's recommended grooving and assembly instructions.
9. Manufacturer's Field Service Representative:
    a. Provide a minimum of one (1) visit to job site to train Contractor's field personnel in the proper use of grooving tools, application of groove, and product installation.
    b. Provide a minimum of one (1) visit to job site to review installation. Contractor shall remove and replace any improperly installed products.

H. Couplings:
1. Use only where indicated on Drawings or reviewed by Engineer. Do not use where restrained fittings are specified.
2. For buried or exposed service, furnish factory applied fusion-bonded epoxy coating in accordance with ANSI/AWWA C213, and corrosion-resistant alloy bolts equivalent to Dresserloy or Type 316 stainless steel.
3. For air service, furnish high temperature EPDM or Viton gaskets rated for 250°F or higher.
4. Shall meet ANSI/AWWA C219: Described by reference to couplings manufactured by Dresser Industries, Inc., Bradford, PA; equivalent couplings by Ford Meter Box, JCM Industries, Romac Industries, or by other manufacturers may be used:
    a. Dresser Style 38 for exposed steel, cast iron, and ductile iron pipe unless indicated otherwise on Drawings or scheduled.
    b. Dresser Style 253 cast iron couplings for buried steel, cast iron, ductile iron, and asbestos cement pipe, unless indicated otherwise on Drawings.
    c. Dresser Style 40 long couplings where long couplings are indicated.
    d. Dresser Style 62 Type reducing couplings where reducing couplings are indicated.

e. Dresser Style 162 couplings for transition between different pipe materials.
f. Dresser Style 63 expansion coupling where expansion coupling is indicated; type as indicated on Drawings or scheduled.
g. Dresser Style 227 and 128 coupling with flanged adaptor where indicated on Drawings.
h. Dresser Style 131 dismantling joint.

I. Pipe Sleeves for Carrier Pipes 22" Diameter or Smaller:
1. Manufactured from non-metallic, non-corrosive, thermoplastic material.
2. Formed to have a water stop and anchor plate at least 4" larger than the main outside diameter and position, unless otherwise specified, in the middle of the sleeve body.
3. Seal shall provide electrical insulation barriers between the pipe and wall.
4. Link-Seal Century Model CS, Thunderline Corporation, or Innerlynx Model PWS.

J. Pipe Sleeves for Carrier Pipes 24" Diameter and Larger:
1. Steel sleeves with full circle waterstop collar continuously welded on both sides hot-dipped galvanized or thermally bonded plastic coating.
2. Link-Seal Model WS or Innerlynx Model Gal-vo-plast®.

K. Mechanical Seals:
1. Watertight, synthetic rubber seal composed of interlocking links joined by bolts, modular sealing element when sleeve is placed in slabs with one side against soil or as shown on Drawings.
2. Rubber links shall completely fill the annular space between pipe and sleeve to provide water tight seal capable of resisting a hydrostatic pressure of 20 psi.
3. Pipe Sleeve Installations: Link-Seal LS for sleeve model CS or Innerlynx Model IL-C.
4. Core Drilled Installations: Link-Seal LS or Innerlynx IL-C.

L. Wall Pipe:
1. Material: DIP or cast iron pipe.
2. Seep Ring: Continuously welded or integrally cast intermediate flange.
3. Size, Thickness and Ends: To match connecting piping.

M. Flex PVC Vinyl Chemical Tubing:
1. Material: Braided clear PVC tubing with polyester reinforcement.
2. Inside Diameter: As indicated or scheduled on the Drawings.
3. Wall Thickness: Equivalent to Herco-Braid Series 0512, standard duty.
4. Working Pressure Rating: 125 psi at 70°F.
5. Joints: PVC hose barb insert fittings with type 304 stainless steel hose clamps.
6. Joint Locations: Do not install joints within containment piping.

N. PVC Containment Piping:
1. Description: Schedule 80 PVC rigid non-metallic conduit (RNC) in accordance with Carlon. Schedule 80 RNC Extra Heavy Wall EPC-80.
2. Size: As indicated or scheduled on the Drawings.

3. Bends: Long sweep elbows in accordance with Carlon standard radius (16" radius for 4" diameter conduit).
4. Joints: Solvent socket weld.

O. Tapping Saddles:
1. AWWA C900 PVC Host Pipe:
   a. Body Material: Bronze or brass.
   b. Strap Material: Type 304L stainless steel.
   c. Style: Two strap.
   d. Rated Working Pressure: At least 200 psig.
   e. Outlet Seal: EPDM O-ring.
   f. Tap Size: As indicated on Drawings.
   g. Conformance: Applicable portions of AWWA C800.
   h. Acceptable Manufacturers: Mueller BR2S, Romac 202BS, Ford 202BSD, or Engineer reviewed equivalent.
2. Ductile Iron Host Pipe:
   a. Body Material: Ductile iron, ASTM A536 with 10 to 12 mil nylon or epoxy coating.
   b. Strap Material: Type 304L stainless steel.
   c. Style: Two strap.
   d. Rated Working Pressure: At least 200 psig.
   e. Outlet Seal: EPDM O-ring.
   f. Tap Size: As indicated on Drawings.
   g. Conformance: Applicable portions of AWWA C800.

P. Tapping Sleeves:
1. Minimum working pressure: 250 psi.
2. Welded, fabricated type 304 stainless steel body with the following features:
   a. Buna-N rubber gasket, gridded, 360 degree pipe coverage.
   b. Type 304 stainless steel bolts and nuts.
   c. Flat face steel flange per AWWA C228, Class D 150 lb. pattern per AWWA C207.
   d. Test Plug: 3/4" NPT, no-lead brass.
3. Ford FTSS, Smith-Blair 663 or JCM 432.
4. Sizes as shown on Drawings.

2.02 ACCESSORIES

A. Dielectric Joint Insulation:
1. General: Complete assembly shall have a pressure rating no less than that of joint and pipeline.
2. Flange Insulating Kits:
   a. Isolating and Sealing Gasket: 1/8" Type E full face phenolic or glass reinforced epoxy retainer with nitrile elastomer ring seal retained in grooves in retainer.
   b. Insulating Bolt Sleeves and Washers: One piece polyethylene sleeve and washer.

c. Metal Washers: Designed to fit over retaining ring on one-piece insulating sleeve and washer, to protect insulating washer from damage by the nut, 1/8" thick hot rolled steel. Provide two washers per bolt.
d. Bolts: Provide all thread bolts because unthreaded portion may not fit inside sleeves. Provide bolt length sufficient to extend 1/8" beyond nut prior to torquing.

3. Tie Rod Insulation:
   a. Insulating Rod Sleeve and Washer: One piece Minlon sleeve and washer. Provide two 1/8" thick ASTM F436 hardened steel washers per insulator.
4. Drinking Water Applications: All materials in contact with drinking water shall be NSF/ANSI 61 certified.
5. Manufacturers:
   a. Advance Products and Systems, Inc., LaFayette, LA.
   b. GPT Industries, Wheat Ridge, CO., formerly PSI Pipeline Seal and Insulator, Inc.

B. Pipe Insulation:
1. Phenolic Resin Bonded Fiberglass:
   a. Property Requirements: ASTM C547.
   b. Maximum Apparent Thermal Conductivity: 0.25 Btu.inch/hour, sq.ft. at 100°F, per ASTM C335.
   c. Dimension Requirements: ASTM C585.
   d. Temperature Limit: 850°F per ASTM C411.
   e. Fire Safety: ASTM E84.
   f. Maximum Linear Shrinkage: 2%, per ASTM C356.
   g. Thickness: Thickness shall be as listed in the following table, unless indicated otherwise in the Contract Documents:

Nominal Pipe Diameter	Insulation Thickness
1/2"	1/2"
3/4"	1"
1"	1"
1-1/2"	1"
2"	1-1/2"
2-1/2"	2"
3"	2"
4"	2-1/2"
6" and larger	3"

2. Waterproofed with Aluminum Roll Jacketing:
   a. T/3003 or T/5005 alloy, gauge 0.016.
   b. Stucco embossed pattern with moisture barrier, continuously laminated across the full width of the jacket.
   c. Factory attached moisture barrier: One mil polyethylene film with a layer of 40# virgin kraft paper.
   d. Moisture Absorption: Less than 5% by weight, ASTM C553.

3. Expanded Metal Wrap:
    a. Hot-dip galvanized steel, gauge 9, 3/4", No. 16-18.
    b. Weight per square foot: 0.51 lb.
    c. Diamond flattened pattern.
    d. Only where specifically indicated on Drawings.

C. Supports and Anchors:
1. Clevis Hangers: FS WW-H-171E, as appropriate or as shown on Drawings.
2. Hanger Rods: ASTM A307, Grade R.
3. Fabricated Supports: Galvanized steel with stainless steel hardware.
4. Beam Clamps: FS WW-H-171E, as appropriate or as shown on Drawings.
5. Concrete Inserts:
    a. Individual: FS WW-H-171E, as appropriate or as shown on Drawings.
    b. Continuous:
        1) Channel 12 gauge, galvanized 1-5/8" x 1-5/8".
        2) Anchor lugs on 4" centers, 2 minimum.
6. Wall Supports and Frames: FS WW-H-171E, as appropriate or as shown on Drawings.
7. Floor Supports:
    a. 6" and smaller: FS WW-H-171E, Type 38.
    b. Larger than 6": FS WW-H-171E, Type 36 or 39.
8. Other: As indicated on Drawings.

D. Pressure Gauges: As specified in Section 40 73 13 – Pressure Gauges, and as shown on Drawings.

E. Pipe Marking Systems for Buried Utilities: Refer to Section 31 23 33 – Trenching and Backfilling.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install as indicated on Drawings.
2. Trenching, Backfilling and Compacting: Section 31 23 33 – Trenching and Backfilling.
3. Pipe cutting measurement taken at site.
4. Clean all pipe, accessories, and appurtenances before use.

B. Flanged Joints:
1. Flange faces to bear uniformly on the gasket and bolts tightened in progressive crisscross order.
2. Tighten flange bolts with a properly calibrated torque wrench set at the following ranges unless otherwise agreed by the Engineer:

Flange Size	**Torque Range (ft-lbs)**
4" through 24"	75 – 90
30" through 36"	100 – 120
>36"	120 – 150

3. All flange bolts at each connection to be uniformly tightened to the specified range.

C. Other Joints:
1. Manufacturer's recommendations.
2. Lubricants: Vegetable soap solution.
3. Solvent cementing of PVC pipe only where scheduled.

D. Clean all lines by repeated flushings after installation.

E. Pipe Sleeves:
1. For pipes passing through concrete or masonry.
2. Install before concrete is placed where practical.
3. Use on all penetrations for line sizes 20" or smaller unless otherwise shown on Drawings or indicated on Schedule.

F. Mechanical Seals:
1. To be used with pipe sleeves and core drilled penetrations.
2. Use only where indicated on Drawings or Schedule for wall penetrations.

G. Wall Pipe:
1. Only where indicated on Drawings or scheduled, provide wall pipe for pipes passing through concrete walls.
2. Install when concrete is placed.
3. Provide tapped holes where wall pipes with flanges are flush with concrete.

H. Floor Penetrations:
1. Install pipe sleeve through floor sized to provide 0.25" to 1.0" annular space around pipe and maximum of 1" projection above top of floor.
2. Pipe sleeve shall be heavy wall PVC or galvanized steel.
3. Pipe sleeve shall contain a 1" wide collar located in center of floor slab.
4. Fill annular space with watertight resilient seal: Type A urethane sealant with joint backer, as specified in the Elastomeric Sealants section.
5. Use on all penetrations unless otherwise shown on Drawings or indicated on Schedule.

I. Anchoring and Supports:
1. Where needed or indicated on Drawings.
2. Section 05 50 10 – Anchor Bolts and Chemical Anchors.
3. Maximum Support Spacing:

Nominal Pipe Size, inches	**Maximum Span, Water Service, feet**	
	Schedule 40 and 80 Rigid PVC	**Schedule 40 Steel**
0.5 and smaller	3	7
0.75	3	7
1	3.5	7
1.5	4.5	9
2	5	10
3	6	12

Nominal Pipe Size, inches	Maximum Span, Water Service, feet	
	Schedule 40 and 80 Rigid PVC	Schedule 40 Steel
4	6.5	14
6	7.5	17
8	8	19
10	8.5	22
12	9.5	23
14	10	25
16	10.5	27
18	11	28
20	11.5	30
24	12.5	32

J. Buried Pipe Anchorage:
1. Furnish and install thrust blocking, anchors, joint restraint devices, or other acceptable means of preventing pipe movement at all of the following locations, whether shown on the Drawings or not:
   a. Unlugged bell and spigot or all unflanged tees.
   b. Y branches.
   c. Bends deflecting 22-1/2 degrees or more.
   d. Plugs.
   e. Fittings in fills or unstable ground.
   f. Above grade or exposed structure.
2. Concrete thrust blocking:
   a. Install thrust blocking so joints are accessible for repair.
   b. Install as shown on Drawings for buried pipe unless otherwise scheduled.
   c. Provide bond breaker, such as 8 mil polyethylene sheet, between concrete and surfaces of all piping, fittings, and appurtenances.

K. Valves: Installed as shown on Drawings with valve boxes and blocking.

L. Pipe Insulation:
1. Where indicated on Drawings.
2. Expanded metal wrap: Where indicated on Drawings.

M. Gas Lines: In full conformance with the requirements and standards of the gas utility to which the gas lines are to be connected and/or to which the gas lines become a part.

3.02 FIELD QUALITY CONTROL

A. Ductile Iron Pipe: AWWA C600, except as specified or shown otherwise.

B. Steel Pipe: AWWA C604, except as specified or shown otherwise.

C. PVC Pipe, and Fusible PVC Pipe: AWWA C605 for pressure rated, and AWWA Manual M23, except as specified or shown otherwise.

D. HDPE Pipe: AWWA C906, AWWA Manual M55, and PPI Handbook of Polyethylene Pipe, except as specified or shown otherwise.

E. All pipes and fittings tested in presence and to the satisfaction of the Engineer.

F. Test Conditions:
1. Low Pressure Air Piping: 10 psi air, check with soap solution, bubble tight.
2. High Pressure Air Piping: 100 psi air, check with soap solution, bubble tight.
3. Exposed Pressurized Water and Wastewater Lines: 150 psi hydrostatic test, no visible leakage for 1 hour.
4. **Do not test PVC, FPVC or CPVC with air** because pipe failure from pressurized air may result in explosive shards.
5. Buried Force Mains Except HDPE: Hydrostatic test at 150% of shut-off head for lift station pumps or 75 psi, whichever is greater, for two-hour minimum; allowable leakage shall be less than that determined by the following formula:
   a. L = (N) (D) (P^0.5) / 133,200
   b. Where:
      1) L = allowable leakage in gallons per hour.
      2) N = length of pipeline tested in feet.
      3) D = nominal diameter of pipe in inches.
      4) P = average test pressure during test, psig.
6. Buried pressure-rated and restrained piping subject to gravity flow and submergence up to 30': 50 psi hydrostatic test for two hours minimum; allowable leakage shall be less than that determined by the formula specified for buried force mains except HDPE.
7. Buried HDPE Force Mains: Hydrostatic test at 150% of shutoff head for lift station pumps or 75 psi, whichever is greater.
   a. Fill Phase: Fill the restrained test section completely with water. Evacuate air from all high points.
   b. Initial Expansion Phase: After the piping and water have equalized to a common temperature, gradually pressurize test section to test pressure, and maintain test pressure for three (3) hours. During the initial expansion phase, HDPE pipe will expand slightly. Add additional water to maintain pressure. It is not necessary to monitor the amount of water added during the initial expansion phase.
   c. Test Phase: Immediately following the initial expansion phase, reduce test pressure by 10 psi, and stop adding test water. If test pressure remains steady (within 5% of the target value) for one (1) hour, no leakage is indicated.
   d. Depressurization Phase: Gradually release the test pressure by controlling the release of water.
   e. Total Test Duration: Limit the time the pipe is pressurized at test pressure to eight (8) hours. If pipe must be pressurized again to test pressure, depressurize pipe first and allow it to relax for at least eight (8) hours before repressurizing.
   f. Supervision: Do not leave the test section unsupervised at any time during leak testing.
8. Other Piping: No detectable leakage under normal or simulated operating conditions.

G. Procedure:
   1. Disconnect fixture, equipment, and accessories which may be damaged by test pressure.
   2. Plug ends as required.
   3. If leakage is indicated, locate and repair leaks.
   4. Retest repaired joints, piping, and fittings until system complies with above criteria for allowable leakage.

3.03 PIPE SCHEDULE

A. HDPE Sewage Forcemain: 12" HDPE (ductile iron pipe size) DR11 with fabricated HDPE bend fittings where required or as indicated on Drawings.

B. As indicated on Drawings.

C. Buried Ductile Iron Piping, Fittings, and all External Restraint Assemblies; and Buried Metal Valves and all Metal Appurtenances: Install with polyethylene encasement.

END OF SECTION

SECTION 40 27 01

IDENTIFICATION SYSTEMS FOR PIPE, VALVES, AND GATES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
1. Color coding, lettering, and tagging of all new exposed pipe in treatment plants and lift stations, and similar facilities.
2. Valve and gate numbering.

1.02 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data, including materials of construction, dimensions, and color selection.

PART 2 PRODUCTS

2.01 MATERIALS

A. Paint: Section 09 97 01 – Industrial Coatings.

B. Metal Tags and Chains: Aluminum or stainless steel, stamped-in identifying letters.

C. Snap-on Markers: Plastic sleeves, Seton Name Plate "Setmark," or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Location of Identification:
1. Pipe lettering and flow directional arrows:
a. Near equipment served.
b. Adjacent to valves.
c. At each branch or tee.
d. At intervals of not more than 50′ on straight runs, unless otherwise indicated by the Engineer.
e. At locations where pipes enter and exit the building and ground.
2. Valves and gate numbers:
a. On box if valve is large enough.
b. On valve box.
c. On gate operator.
d. Metal tag attached to valve with chain.

B. Metal Tags:
   1. Instead of lettering on pipe 5/8″ or smaller (including covering) outside diameter.
   2. Color code as specified.

C. Lettering:
   1. Paint, stencil or use snap-on markers.
   2. Pipe letter size as follows:

Outside Diameter of Pipe or Covering	Minimum Height of Letters
5/8″ or smaller	Metal tags – 1/4″
3/4″ through 4″	3/4″
5″ or larger	2″

D. Valve letter size 2″ if possible, on valve or valve box, 1″ minimum on valve or valve box or metal tag with 1/4″ lettering if 2″ lettering is not possible.

E. Schedule Color Coding:
   1. All exposed pipe.
   2. Bands where scheduled: 6″ wide at 5′ intervals.
   3. Provide only bands of color on uninsulated stainless steel and PVC; elsewhere natural finish.
   4. If two colors adjacent to each other do not have sufficient contrast to easily differentiate between the two, a 6″ band of contrasting color shall be on one of the pipes at approximately 30″ intervals. The name of the liquid or gas shall also be labelled on the piping using the lettering described in Paragraph 3.01 C. of this Section.

F. Piping Not Scheduled:
   1. Paint to match wall or ceiling, unless otherwise directed by Engineer.
   2. Appropriately identify and place flow arrows.
   3. Uninsulated stainless steel and PVC.
      a. Natural finish.

G. Valve and Gate Numbers:
   1. Assigned by Engineer after installation.
   2. Maximum of six letters/figures.

3.02 SCHEDULE

A. Pipe Identification Schedule (following page):

WASTEWATER FACILITIES		
LETTERS	COLOR OF PIPE	COLOR OF LETTERS
Potable Water (hot or cold)	Light blue	Black
Service Water (lines downstream from a backflow prevention unit)	Light blue with white bands	Red
Sewage	Light gray	Black
Paint electrical conduit, except vinyl-coated conduit, to match adjacent ceiling or wall surfaces, as directed by the Engineer. Paint vent lines to match surfaces they adjoin.		

In addition, special painting of the following items will be required:

Item	Color
Hoist Hooks and Blocks	Yellow and Black Stripes

END OF SECTION

SECTION 40 27 02.01

PLUG VALVES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Plug Valves, Actuators, and Accessories.

1.02 RELATED SECTIONS

A. Section 40 27 00 – Process Piping Systems.

1.03 REFERENCES

A. American Water Works Association (AWWA):
1. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C116 – Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray-Iron Fittings.
3. AWWA C517 – Resilient-Seated Cast-Iron Eccentric Plug Valves.

B. American National Standards Institute (ANSI):
1. ANSI/ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. American Society for Testing and Materials International (ASTM):
1. ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 – Ductile Iron Castings.

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data for valves and actuators.
2. Dimensions.
3. Materials of Construction.
4. Weights.
5. Rated pressure.
6. Recommended orientation of plugs and actuators.

B. Section 01 78 23 – Operation and Maintenance Data.

C. Proof of Design in accordance with AWWA C517.

D. Pressure ratings established by hydrostatic tests: ANSI B16.1.

E. Electric Actuator Compatibility Certification: Per Part 2 of this Section.

1.05 SERVICE CONDITION

A. Raw and partially treated sewage, sewage sludge, and digester gas or other uses as scheduled.

1.06 ADDITIONAL REQUIREMENTS

A. All plug valves provided by same manufacturer.

B. Manufacturer's name and pressure ratings cast on body.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. DeZurik. The Contract Drawings are laid out using DeZurik valve laying lengths. If Contractor selects a different valve manufacturer, Contractor shall provide, at no additional cost to the Owner, any changes in piping required to accommodate different laying lengths.

B. Henry Pratt.

C. Val-Matic.

D. Or Engineer reviewed equivalent.

2.02 DESIGN REQUIREMENTS

A. Drip-tight shut-off under following pressures in either direction:
1. Sizes through 12": 175 psi.
2. Sizes 14" through 36": 150 psi.
3. Sizes 42" through 54": 125 psi.

B. Materials and Construction:
1. Valve Type: Non-lubricated, eccentric.
2. Valve Body and Plug: ASTM A126 Class B cast iron and AWWA C517, or ASTM A536 Class 65-45-12 ductile iron.
3. Resilient Plug Facings:
   a. Neoprene or Buna-N for sewage, sludge or water.
   b. Nitrile-butadiene (Hycar) for digester gas service except for compressor discharge valves.
   c. Fluorinated hydrocarbon for digester gas compressor discharge valves.
4. Flanged Valves: Faced and drilled to the ANSI 125/150 lb. standard.
5. Mechanical Joint Ends: AWWA C111.
6. Bell Ends: AWWA C100 Class B.
7. Screwed Ends: NPT standard.
8. Body Seats: Welded alloy with 95% minimum nickel content, AWWA C517.
9. Sleeve type bearings in upper and lower journals: Replaceable.

10. Bearing Material: Stainless steel or Teflon with Non-Metallic Backing, AWWA C517.
11. Valve Shaft Seals: AWWA C517.
12. Port Areas: At least 100% of full pipe area.
13. Exposed Nuts, Bolts, Springs, and Washers: Zinc plated.

C. Valve Operators:
1. General: AWWA C517.
2. Buried:
   a. AWWA 2" direct opening nut for 6" to 4" valves.
   b. Manufacturer's standard manual valve box actuator for 3" and smaller.
   c. Enclosed waterproof gear operator with 2" nut for 8" and larger.
   d. Furnished with stem extension, valve box, and valve position indicator.
3. Exposed:
   a. Within 5' of operating floor:
      1) Wrench operated for 6" and smaller valves.
      2) Enclosed gear operator with handwheel for 8" and larger valves.
   b. Located more than 5' above operating floor: Enclosed gear operator equipped with chainwheel and sufficient length of chrome plated chain to reach within 4' of operating floor.
   c. Unless otherwise indicated on Drawings.
4. Floor Stands (where indicated on Drawings):
   a. Located directly over valve.
   b. Enclosed gear operator with handwheel mounted to floor stand.
5. Enclosed Gear Operators: Traveling nut-type to produce required unseating torque at the maximum differential pressure listed at the end of this Section with not more than 80 lbs. of pull.
6. Electric Valve Actuators: See Division 40.
7. Manual Operation: Open left (counter clock-wise), valve position indicator on valve body.

2.03 PROTECTIVE COATINGS

A. Corrosion Protection – Buried and Exposed Valves:
1. Factory Surface Preparation (Interior and Exterior): SSPC-SP10 Near-White Blast Cleaning.
2. Factory Coating (Interior and Exterior): Fusion-bonded epoxy, AWWA C116, 12 mils dry film thickness.

2.04 MAINTENANCE MATERIALS

A. Spare Parts: As scheduled at the end of this Section.

2.05 ASSEMBLY REQUIREMENTS FOR BURIED VALVE INSTALLATIONS

A. Valve manufacturer required to supply complete assembly, including valve, valve accessories, valve box, and integral position indicator; refer to Section 40 27 02.10 – Valve Boxes, for valve box requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Manufacturer’s recommendations.

B. In Horizontal Pipelines: Plug shaft in horizontal position whenever possible with plug above flow when valve is open.

C. In Vertical Pipelines: Seat end at top of valve.

D. Seat to be located on downstream side of flow except at pumps. At pumps, seat to be located on pump side.

3.02 SCHEDULE

A. As shown on the Drawings.

END OF SECTION

SECTION 40 27 02.09

MISCELLANEOUS VALVES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install all miscellaneous valves specified herein.

1.02 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples: Product data for all items listed in PART 2 PRODUCTS, except for hose bibbs and plug cocks.

B. Section 01 78 23 – Operation and Maintenance Data: Operation and Maintenance Manuals for all items listed in Part 2 PRODUCTS, except for hose bibbs, plug cocks, stop gates, gate valves under 4″, and elastomeric check valves.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Same manufacturer for each type of valve throughout where practical.

B. Manufacturer's name or initials and working pressure ratings cast on valve body.

2.02 DESIGN REQUIREMENTS

A. General: Unless otherwise indicated, use valves suitable for 125 minimum psi WOG and 150°F.

B. Lead Free: All materials in contact with potable water shall be lead-free, as certified by the Water Quality Association to comply with NSF/ANSI 372, and shall be NSF 61 compliant.

C. Yard Hydrant:
1. Iron body, brass plugs and washers, air tested, screwed ends, 1-1/4″ galvanized steel pipe, 3/8″ galvanized steel operating rod.
2. Non-freeze type, 1/8″ NTP tapped drain hole.
3. 1″ threaded hose connection or as shown on Drawings. Fitted with universal quick acting (crow foot) coupling.
4. Maximum Pressure: 125 psi.
5. Maximum Temperature: 120 °F.
6. Woodford, Colorado Springs, CO or Engineer reviewed equivalent.

D. Gate Valves:
1. 3″ or smaller:
a. Bronze body and wedge with threaded ends, non-rising stem; Grinnel or Engineer reviewed equivalent.
b. Pressure rating: 200 psi non-shock cold water, oil, or gas, unless otherwise scheduled or shown on Drawings.
c. Furnish gate valves for buried lines with valve key operator.
d. 4 ″or larger: See Section 33 12 01 – Water Systems.

E. Globe Valves 3″ and Larger: Cast iron body, bronze seat and disc, bolted bonnet, outside stem and yoke, Class 125 flanged ends, 8″ hand wheel, 200 psi non-shock WOG, Nibco F-718-B or Engineer reviewed equivalent.

F. Globe Valves 2-1/2″ and Smaller: Bronze, rising stem, inside screw, renewable composition disc, screwed or flanged ends.

G. Air/Vacuum and Air Release Valves:
1. Sewage Service Air Valves:
a. Functions - furnish type and size of sewage service air valves as scheduled or as noted on Drawings:
1) Air Release Valves: Releases air pockets during system operation.
2) Air/Vacuum Valves: Exhausts large quantities of air at system start-up, and introduces air to protect system from vacuum.
3) Combination Air Valves (CAV): Releases air pockets during system operation, exhausts large quantities of air at system start-up, and introduces air to protect system from vacuum.
b. Conformance: AWWA C512.
c. Valve Pressure Rating: 150 psi., unless otherwise scheduled or shown on Drawings.
d. Body, Cover, and Baffle: Cast iron or ductile iron.
e. Interior and Exterior Coating: Fusion bonded epoxy in accordance with AWWA C550.
f. Orifice, Float, Arm, Retainer, Guide Bushing, Retainer, Orifice Button, and Other Trim: Type 316 stainless steel.
g. Seats: Buna-N.
h. Piping Appurtenances: Inlet plug valve and vent return leg piping, unless otherwise shown on Drawings.
i. Drain Valve Inspection Piping: Install stainless steel ball valve and stainless steel fittings on air valve body lower drain tap in accordance with manufacturer’s Operation and Maintenance Manual to facilitate performance testing.
j. Backwash Accessories: Assembled with valves, including an inlet shut-off valve, a blow-off valve, a clean water inlet valve, rubber supply hose, and quick disconnect couplings. Accessory valves to be quarter-turn, full ported bronze ball valves. Number of accessory valves per assembly as recommended by sewage air valve manufacturer.

H. PVC Ball Valves for Exposed Plastic Pipe Installations:
1. Construction: PVC with true union ends.
2. PVC: ASTM D1784 cell classification 12454A.
3. Pressure Rating:
   a. 230 psi at 70ºF for 0.5″ to 2″.
   b. 150 psi at 70ºF for 2.5″ to 6″.
4. Bore: Full bore for 0.5″ to 2″.
5. Operator: T-handle.
6. "O" Ring Seals: EPDM.
7. Ball Seats: P.T.F.E. (Teflon ®) with elastomeric backing cushions. Blocks flow in two directions: upstream and downstream. Bubble-tight shutoff.
8. Ball Valves for Drinking Water Applications: Non-toxic NSF-61 Certified.
9. Ball Valves for Hypochlorite Solution Service: Vented ball.

I. Bronze Ball Valves for Exposed Metal Pipe Installations, 1/4″ to 4″:
1. Body and Adapter: Lead free copper silicon alloy.
2. Style: Two-piece, standard port.
3. Pressure Rating:
   a. 600 psi WOG non-shock at 300ºF for 1/4″ to 3″.
   b. 400 psi WOG non-shock at 250ºF for 4″.
4. Ball: Type 316 stainless steel.
5. Seat: Carbon/glass filled or enhanced PTFE.
6. Body Seal: PTFE.
7. Stem: Type 316 stainless steel, blowout-proof.
8. Stem Packing: Glass reinforced, PTFE.
9. Stem Packing Nut: Brass, ASTM B16, C36000, adjustable packing gland.
10. Lever Handle and Nut: Zinc plated carbon steel.
11. Handle Sleeve: Vinyl.

J. Stainless Steel Ball Valves for Exposed Metal Pipe Installations, Including Air Valve Isolation, 1/4″ to 3″:
1. Body, End Cap and Ball: Type 316 wrought stainless steel, or ASTM A351 grade CF8M cast stainless steel.
2. Style: Two-piece, standard port.
3. Pressure Rating: 1,000 psi WOG at 100ºF.
4. Seat and Body Seal: RPTFE.
5. Stem: Type 316 stainless steel, blow-out proof.
6. Stem Packing: RPTFE.
7. Stem Packing Gland: Type 304 stainless steel.
8. Lever Handle and Nut: Type 304 stainless steel with safety latch locking device.
9. Handle Sleeve: Vinyl.

K. Reduced Pressure Backflow Preventer:
1. Assembly shall consist of two independently operating, spring loaded, "Y" pattern check valves and one hydraulically dependent differential relief valve.

2. Automatically reduce the pressure in the zone between the check valves to at least 5 psi lower than inlet pressure.
3. Mainline valve body and caps including relief valve body and cover: Bronze.
4. Seat Discs: Nitrile, reversible.
5. Diaphragms: Fabric reinforced nitrile.
6. Springs: Stainless steel.
7. Diaphragm to seat area ratio: 10 to 1 minimum.
8. 175 psi water working pressure rating and water temperature range from 32ºF to 180ºF.
9. FEBCO Model LF825Y (up to 2″) or Engineer reviewed equivalent.
10. FEBCO Model LF860 (2-1/2″ to 10″) or Engineer reviewed equivalent.
11. Conformance:
    a. AWWA C511 – Reduced Pressure Principal Backflow Prevention Assembly.
    b. Approved by the Foundation for Cross Connection Control and Hydraulic Research at USC.
    c. And listed in the American Society of Sanitary Engineering International (ASSE) "Prevention Rather Than Cure" Seal Authorization Booklet.
12. Furnish with air gap drain funnel and 1″ Sch. 80 PVC drain piping to the nearest floor drain or through wall to daylight, unless shown otherwise on Drawings.
13. Shutoff Valves: Fully ported ball valves, integral with assembly.

2.03 PROTECTIVE COATING

A. Factory enamel paint unless specified otherwise.

PART 3 EXECUTION

3.01 INSTALLATION

A. Manufacturer's recommendations.

B. Per code or best trade or industry practice.

C. As indicated on Drawings.

3.02 SCHEDULE

A. As indicated on Drawings.

END OF SECTION

SECTION 40 27 02.10

VALVE BOXES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Boxes for all buried, manually operated valves, and appurtenances.

B. Box covers with cast markings.

1.02 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
   1. Product data for all items specified in Part 2 – Products.

B. Section 01 78 23 – Operation and Maintenance Manual for valve position indicators.

PART 2 PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. ASTM A48 Class 35 cast iron, adjustable screw extension type, traffic type.

B. Minimum thickness of metal at any point: 3/16”.

C. Coating: Asphaltic bituminous coating, inside and out, 1.5 mil minimum thickness.

D. Removable cast iron cover, 5-1/4” diameter standard drop lid, cast marking with words, “WATER”, “SEWER”, “REUSE”, or “GAS” to match appropriate utility.

E. Cast iron base properly sized to fit over valve bonnet and bear on bricks, as shown on Drawings.
   1. Base shall be large enough to extend 6” below bottom of valve operating nut.
   2. Base shall be large enough so no part of the base or its bearing bricks shall bear on any part of the valve.

F. For valves on washwater and irrigation system only: Class 200 PVC pipe.

G. Furnish valve stem extension to position standard AWWA 2” operating nut within 3.5’ to 2.5’ below the lid.

PART 3 EXECUTION

3.01 INSTALLATION

A. Per AWWA Manual M44: Distribution Valves: Selection, Installation, Field Testing, and Maintenance, Latest Edition.

B. With concrete collar, as shown on Drawings.

C. Shall not bear on pipe or valve.

3.02 SCHEDULE

A. As indicated on Drawings.

END OF SECTION

SECTION 40 27 02.12

BALL CHECK VALVES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provision and installation of all ball check valves used in wastewater service or other fluids as shown on Drawings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
1. ASME/ANSI B16.10 – Face-to-Face and End-to-End Dimensions of Valves.
2. ASME/ANSI B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.

B. American Society for Testing and Materials International (ASTM):
1. ASTM A536 – Ductile Iron Castings.
2. ASTM D2000 – Standard Classification System for Rubber Products in Automotive Applications.

C. American Water Works Association (AWWA):
1. AWWA C116 – Protective Fusion–Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings.

1.03 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data.
2. Design criteria.
3. Dimensioned drawings.
4. Parts list.
5. Materials of construction.
6. Weights.
7. Installation instructions.

B. Section 01 78 23 – Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Factory Testing – All valves shall be factory pressure tested to design shell pressure, and leak tested to design seating pressure.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Flygt HDL Ball Check, Type 5087/AVK Series 53.

B. Or Engineer reviewed equivalent.

2.02 DESIGN REQUIREMENTS

A. Service: Water, stormwater, and raw sewage containing solids, stringy material, rags and grit, without clogging or need for backflushing.

B. Design: Ball is the only moving part, which automatically rolls out of the path of flow, thus providing an unobstructed opening equal to nominal pipe size. Upon discontinuation of flow the ball automatically rolls back to closed position, providing a positive seal against back pressure.

C. Rated Working Pressure:
1. Shell Test: 225 psi.
2. Seat Test: 145 psi.

D. Maximum Liquid Temperature: 160°F

2.03 VALVE CONSTRUCTION AND MATERIALS

A. Body:
1. Ductile iron ASTM A536, Grade 65-45-12.
2. Ends: Flanged, bolt pattern ANSI B16.42 Class 150 flat faced.
3. Laying Lengths: In conformance with ASME/ANSI B16.10 for swing check valves.
4. Removable bolt-on cover for access to ball.

B. Ball:
1. Hollow aluminum core encapsulated with vulcanized NBR nitrile rubber.
2. Specific gravity: Greater than 1.0 (sinking ball type).

C. Bonnet Bolts and Nuts: Type 316 Stainlesss steel.

D. Bonnet Gasket: Buna N Nitrile rubber, ASTM D2000.

2.04 PROTECTION COATING

A. Shop: Fusion bonded epoxy, inside and outside.

B. Field: Section 09 97 01 – Industrial Coatings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves where indicated by Drawings following manufacturer's recommended procedures.

3.02 SCHEDULE

A. Service Condition: Used in force main piping for raw wastewater.

B. As indicated on Drawings.

END OF SECTION

SECTION 40 60 10

INSTALLATION, TESTING, AND CALIBRATION OF INSTRUMENTATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation and testing of instrument circuits.

B. Installation, calibration, and testing of instruments.

C. Test equipment for testing and calibration of instrumentation.

1.02 SYSTEM REQUIREMENTS

A. For purposes of this section, “instrument” means:
   1. A transmitter which measures a process variable and produces an analog signal, such as 4 to 20 mA, 1 to 5V, or similar.
   2. Other analog devices which produce or utilize mA or similar signals, such as indicators and isolators.
   3. A switch which measures a pressure, temperature, or similar, in an analog fashion but produces a discrete output. This does not include float switches.

B. Instrumentation refers to the entire system of instruments and associated indicators, circuits, and accessories.

C. Provide minor pipe, fittings, adapters, valves, tubing, supports, and accessories to make a complete, operating installation for each instrument, whether shown on the Drawings or not.

D. Provide labor to accomplish a complete, tested, calibrated, and correctly operating installation.

1.03 SUBMITTALS

A. Assemble calibration reports in electronic format in order of Tag Number. Include project information along with each Submittal. The information in the reports having been field verified, this Submittal will be reviewed only for completeness.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION OF CIRCUITS

A. Use type and size of wire or cable specified in Section 26 05 19 – Low Voltage Wire and Cables, or as shown on the Drawings, whichever is larger.

B. Color code and label every wire end as specified in Section 26 05 19 – Low Voltage Wire and Cables.

C. Run instrumentation circuits unbroken, such as from instrument to Surge Protective Device (SPD) to indicator to programmable logic controller (PLC), with no intermediate connection except:
   1. Where terminal boards are shown on the Drawings.
   2. Where terminal boards with appropriate enclosures are proposed by the Contractor and allowed in writing by the Engineer.

D. Connect to remote terminal unit (RTU), remote control panel (RCP), PLC or similar controller input/output (I/O) terminals only after testing specified below is complete.

E. Maintain physical separation between direct current (DC) instrumentation circuits and all alternating current (AC) circuits.

F. The quantity, type, and American wire gauge (AWG) of wire and cable called for on the Drawings is for facility equipment as designed. If equipment is furnished which requires a greater quantity of, different type or larger AWG wire or cable than called for, then furnish the correct quantity, type and AWG plus appropriate conduit at no additional cost to the Owner. Submit proposed changes to Engineer for review.

3.02 TESTING OF CIRCUITS

A. Conduct testing to verify that analog circuits and associated DC power circuits are properly installed and connected, that there are no shorts, and that there are no unintentional grounds on the signal conductors. Lift intentional grounds from shields and verify that there are no unintentional grounds on the shields.

B. Connect circuits to the terminals of the controller and connect shield grounds.

C. Provide all test equipment.

3.03 INSTALLATION OF INSTRUMENTS

A. Coordinate installation of instruments such that instruments are installed by appropriately skilled workers and such that all necessary labor and materials are included in the Bid. For example, determine the appropriate trade for the installation of a 24″ electromagnetic flow element versus the transmitter and the installation of a conductivity analyzer probe versus the transmitter and assign the work accordingly.

Also determine which trade will provide and install such adapters and hardware as needed for a complete, working installation. For another example, determine in advance which trades will install thermal wells versus temperature transmitter elements.

B. Follow recommendation and instructions of equipment manufacturer in addition to requirements of Drawings and Specifications in handling and installation of instrumentation equipment.

C. Cleaning: Before assembly or installation, thoroughly clean equipment of temporary protective coatings and foreign materials. After installation of equipment, clean external surfaces of oil, grease, dirt, or other foreign material.

D. Mount instrumentation equipment approximately where shown on the Drawings. Propose exact locations to the Engineer in advance of mounting. Mount with pipe stands, brackets, or strut as specified and as shown on the Drawings. If not detailed on the Drawings, propose bracket details in the field. Provide floor stands where instruments are located away from walls or other building structure. Provide manufacturers' mounting adapters as needed.

E. Painting: Painting is not required for aluminum, galvanized steel, or stainless steel.

F. Transmitters Which are Separate from their Sensing Element:
   1. Transmitters not in a building:
      a. Mount the transmitter so the display faces north.
      b. If not practical to face north, so demonstrate to the Engineer, then face east.
      c. Only with written approval from the Engineer, face the display south or west.
   2. Mount the transmitter at a convenient height (approximately 64″ centerline) above the finished walking surface (grade).
   3. Mount the transmitter so it is easily accessible for reading, testing, and calibration.
   4. Provide manufacturer-furnished or recommended cable for connection of sensing element to transmitter.

G. Transmitters Which are Integral with their Sensing Element:
   1. If piping run or structure permits, mount the transmitter between 18″ and 72″ above grade and so the transmitter is easily accessible for reading, testing, and calibration.
   2. Where the Drawings show transmitters more than 72″ above grade or where the piping run or structures require mounting the transmitter more than 72″ above grade, locate the transmitter where access by means of a ladder is convenient.

3. Transmitters in a building:
    a. If the transmitter is mounted high and is adjustable, face the display downward, angled for operator convenience.
    b. If the transmitter is at an intermediate height and is adjustable, adjust angle for operator convenience.
    c. If the transmitter is mounted low and is adjustable, face the display upward, angled for operator convenience.
4. Transmitters not in a building:
    a. If the transmitter is mounted high and is adjustable, face the display downward, angled for operator convenience.
    b. If the transmitter is mounted at an intermediate height, if practical, mount the transmitter so the display faces north. If not practical to face north, so demonstrate to the Engineer, then face east. Only with written approval from the Engineer, face the display south or west.
    c. If the transmitter is mounted low, face upward unless shown otherwise on the Drawings. Provide sunshade similar to the requirements below but with a hinged portion on top to protect the display from the sun. Mount sunshade to a bracket which is independent of the process pipe or vessel.
    d. If mounted to tap on tank for level measurement, include hot box with heat tape to prevent tap from freezing during cold weather conditions.

H. Local Indicators:
1. Mount the indicator at a convenient height (approximately 64″ centerline) above the finished walking surface (grade).
2. Mount the indicator so it is easily accessible for reading, testing, and calibration.
3. Face the display the same as required for separately mounted transmitters.

I. Sunshades:
1. Provide sunshades for all LED and LCD displays of separately mounted transmitters and local indicators which are not within a building and which are not facing north, whether sun shades are shown on the Drawings or not. Also provide sunshades for other transmitters where noted on the Drawings.
2. The purpose of sunshades is to protect the readout from direct sun and to allow easier reading of the display by an operator. Fabricate and install accordingly. An acceptable design is 14 gage aluminum plate with two bends formed in it and mounted so it extends 3-4″ beyond the front of the transmitter or indicator on the left, top, and right, complete with a top-hinged flap which completely shades the display except when lifted by hand. Make all corners smooth, especially the upper two corners. Mount so the sunshade stands off from the enclosure of the transmitter or indicator to allow for air circulation. Mount with stainless steel (SS) hardware. Other designs may be proposed for review by the Engineer.

J. Nameplates:
1. Install an engraved nameplate to identify each instrument.

2. If text is not shown on the Drawings, show function and tag number of instrument.

3.04 CALIBRATION OF INSTRUMENTS

A. Provide all test and calibration equipment. Unless equipment is new for this project, provide current National Institute of Standards and Technology traceable calibration information for it.

B. Calibrate the following instruments in place and demonstrate correct calibration as installed, under simulated operating conditions. For calibration range, see Instrumentation and Control Wiring Schedule and Tag List. If not shown, see Drawings. If not shown, obtain information from Engineer during construction.
1. Temperature transmitters.
2. Pressure transmitters.
3. Level transmitters.
4. Open channel flow meters.
5. Electro-Magnetic flowmeters.
6. Other flow meters offering field calibration capability.
7. Analyzers, such as dissolved oxygen, pH, digital output (DO), oxidation-reduction potential (ORP), Total Dissolved Solids (TDS), and similar process analyzers.
8. Valve position analog indicators.
9. Transmitters for electrical values, such as voltage, current, and watt transducers.
10. Temperature switches, pressure switches, and the like.

C. Provide certificates of factory calibration for instruments for which the manufacturer provides no means of field calibration, such as the flow element of an electromagnetic flow meter.

D. Some instruments contain small meters or gauges, which cannot be calibrated in the field, to indicate output signals. Record the performance of these indicators as if an external indicator.

E. Verify that the instrument is working while isolated.

F. Notify Owner and Engineer minimum 6 working days in advance of calibrating an instrument. The Owner or Engineer will witness the calibration and sign the calibration report, but only to denote presence as a witness.

G. Calibration Procedure:
1. Remove shipping stops/plugs from instruments before starting.
2. Have instruction manuals available and install miscellaneous components which have been supplied separately but are integral parts of equipment.

3. Nameplate check: Verify data on nameplate with respect to conditions of range, operating temperature, specific gravity, and other ratings required by the Specifications and as submitted. Correct discrepancies before proceeding.
4. For analyzers, use standard solutions or mix solutions strictly in accordance with manufacturer's instruction.
5. Calibrate each instrument in accordance with manufacturer's calibration procedures over full operational range. Prove instruments to be within published specification and accuracy. Then calibrate the entire loop, including wiring, remote indicators, loop isolators, and SPD. Prove each item in loop to be within published accuracy.
6. Where an instrument loop controls a plant variable, such as return activated sludge (RAS) flow rate, calibrate the loop as a system (i.e., transmitter, controller, and variable-frequency drive [VFD]). Components which have adjustable features shall be carefully set for specific conditions and applications of this project.
7. Place a calibration sticker on each active component of the loop, showing:
    a. Calibration report number and date.
    b. Equipment identification tag number.
    c. Printed name of person who performed calibration.
8. Prepare and submit a calibration report for each loop, showing the below information. Provide serial number where shown on the equipment name plate, although it is recognized that not all items will bear a serial number.
    a. Calibration report number and date.
    b. Owner's name and project name.
    c. Service of instrument, such as "RAS flow."
    d. Equipment identification tag number.
    e. Engineering name of variable of interest, such as "Level," even though it is being measured by a pressure transmitter.
    f. List of equipment used to independently measure process variable.
    g. For Analyzers:
        1) Manufacturer's name and catalog number for standard solutions.
        2) Method of use of solutions.
    h. For Transmitters:
        1) Manufacturer's name, model number(s), and serial number(s) for transmitter and element.
        2) Range of capability of transmitter.
        3) Calibrated range for this project.
        4) Table showing actual value of measured variable versus mA output of transmitter. Show minimum of two such points. Some Sections may require more than two calibration points.
    i. For Signal Isolators in the Loop:
        1) Manufacturer's name, model number, and serial number.
        2) Table showing mA in versus mA out at 0%, 50%, and 100%.

j. For Signal Converters in the Loop:
    1) Manufacturer's name, model number, and serial number.
    2) Table showing signal-in versus signal out at 0%, 50%, and 100%.
k. For Indicators in the Loop:
    1) Manufacturer's name, model number, and serial number.
    2) Table showing signal-in versus reading at 0%, 50%, and 100%.
l. For Switches:
    1) Manufacturer's name, model number, and serial number.
    2) Table showing value of process variable versus contact action.
m. Date of calibration.
n. Printed name of person who performed calibration. Signature.
o. Printed name of person who witness calibration. Signature.

END OF SECTION

SECTION 40 60 20

INSTALLATION AND TESTING OF CONTROL CIRCUITS AND DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation and testing of control circuits.

B. Installation and testing of control devices.

1.02 SYSTEM REQUIREMENTS

A. Definition of a Control Device:
1. A device which measures a process variable, such as a level switch, and produces a discrete signal. Certain switches which respond to analog process variables, such as pressure switches and temperature switches, are treated as if they are instruments under Section 40 60 10 – Installation and Testing of Control Circuits and Devices.
2. Hand switches that are field mounted. Hand switches in control panels are covered under Section 40 78 10 – Control Hardware, and Sections referenced therein.
3. Relays that are field mounted. Relays in control panels are covered under Section 40 78 10 – Control Hardware, and Sections referenced therein.
4. Indicator lights, horns, alarm strobes, and similar discrete operator interface devices that are field mounted.
5. Other devices which produce a discrete signal.
6. Other similar devices that are neither instrumentation nor power devices.

B. Controls refers to the entire system of control devices and to all circuits associated with the plant control system in the larger sense, except for those circuits covered under Section 40 60 10 – Installation and Testing of Control Circuits and Devices.

C. Provide labor to accomplish a complete, tested, and correctly operating installation.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 INSTALLATION OF CIRCUITS

A. Use type and size of wire or cable specified in Section 26 05 19 – Low Voltage Wire and Cables, or as shown on the Drawings, whichever is greater.

B. Color code and label every wire end as specified in Section 26 05 19 – Low Voltage Wire and Cables.

C. Run control circuits from control device to control device to control panel with no intermediate connection except:
   1. Where terminal boards are shown on the Drawings.
   2. Where terminal boards with appropriate enclosures are proposed by the Contractor and allowed in writing by the Engineer.

D. Connect to remote terminal unit (RTU), remote control panel (RCP), programmable logic controller (PLC), or similar controller I/O terminals and power-up equipment only after testing specified below is complete.

E. Maintain physical separation between DC instrumentation circuits and all AC circuits.

F. The quantity, type, and AWG of wire and cable called for on the Drawings is for facility equipment as designed. If equipment is furnished which requires a greater quantity of, different type or larger AWG wire or cable than called for, then furnish the correct quantity, type and AWG plus appropriate conduit at no additional cost to the Owner. Submit proposed changes to the Engineer for review.

3.02 TESTING OF CIRCUITS

A. Conduct testing to verify that control circuits and associated power circuits are properly installed and connected, that there are no shorts, and that there are no unintentional grounds on the conductors. Lift intentional grounds for and verify that there are no unintentional grounds on the neutral conductors.

B. Connect circuits to the terminals of the controller and connect intentional grounds.

C. Provide all test equipment.

3.03 INSTALLATION OF CONTROL DEVICES

A. Coordinate installation of control devices such that devices are installed by appropriately skilled workers and such that all necessary labor and materials are included in the Bid. Also determine which trade will provide and install such adapters and hardware as needed for a complete, working installation. For another example, determine in advance which trades will install concrete that might be needed for support of stands for control devices.

B. Follow recommendation and instructions of equipment manufacturer in addition to requirements of Drawings and Specifications in installation of control devices.

C. Cleaning: Before assembly or installation, thoroughly clean equipment of temporary protective coatings and foreign materials. After installation of equipment, clean external surfaces of oil, grease, dirt, or other foreign material.

D. Mount control devices approximately where shown on the Drawings. Propose exact locations to the Engineer in advance of mounting. Mount with pipe stands, brackets, or strut as specified and as shown on the Drawings. If not detailed on the Drawings, propose bracket details in the field. Provide floor stands where control devices are located way from walls or other building structure.

E. Painting: Paint ferrous, custom or field-fabricated brackets, stands, and miscellaneous mounting members as specified in Division 9. Painting is not required for aluminum, galvanized steel, or stainless steel.

F. Mount control devices at a convenient height (approximately 54" centerline) above the finished walking surface (grade), where it is easily accessible to the plant operator and for maintenance.

3.04 TESTING OF CONTROL DEVICES

A. First, test control devices individually.

B. Then, test control devices as part of a system, such as operating a motor in HAND. Verify that every motor operates correctly in HAND and that control devices such as float and limit switches operate correctly as part of the system.

C. Perform other testing of control devices as required by Section 40 80 00 – Process Control Equipment Commissioning.

D. Notify Engineer minimum 6 working days in advance of testing control devices as part of a system. The Engineer will either witness the testing or notify the Contractor that witness testing is waived for all or part of the devices.

END OF SECTION

SECTION 40 61 13

CONTROL SYSTEM DOCUMENTS AND PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Process Control System (PCS), including hardware, software, and system integration.

B. Control panels, operator interface systems, and related appurtenances.

C. Documentation, submittals, procedures, testing, training, and O&M manuals associated with PCS.

1.02 RELATED SECTIONS

A. Division 01 – Administrative Requirements.

B. Division 26 – Electrical.

C. Section 40 60 10 – Installation, Testing, and Calibration of Instrumentation.

D. Section 40 60 20 – Installation and Testing of Control Circuits and Devices.

E. Section 40 61 93 – Instrumentation and Control Wiring Schedule and I/O Tag List.

F. Section 40 61 96 – Process Control Descriptions.

G. Section 40 67 10 – Control Panels.

H. Section 40 80 00 – Process Control Equipment Commissioning.

1.03 ABBREVIATIONS

A. HMI – Human Machine Interface.

B. I/O – Input/Output.

C. OIU – Operator Interface Unit (Operator Workstation).

D. OIT – Operator Interface Terminal (Panel-Mounted Touchscreen).

E. OIS – Operator Interface System (servers, workstations, OITs, hardware, and HMI software).

F. PCS – Process Control System.

G. PLC – Programmable Logic Controller.

1.04 SUBMITTALS

A. Action Submittals

1. Contact information for PCS Integrator key personnel:
   a. Project Manager.
   b. Project Engineer.
   c. Field Service Representative(s).

2. Shop Drawings for:
   a. Control panels.
   b. Terminal enclosures.
   c. Connection diagrams.
   d. Nameplate/engraving schedules.
   e. Schematic diagrams (AutoCAD, PDF).

3. OIU/OIT screen layouts, tag lists, and narrative descriptions.

4. Bills of Material (BOM), itemized by system component.

B. Informational Submittals

1. Product data and catalog cuts.

2. Manufacturer installation instructions.

3. Software descriptions, licenses, and registration information.

4. Test procedures and reports in accordance with referenced Sections.

C. Closeout Submittals

1. Operation and Maintenance (O&M) Manuals:
   a. Hardcopy (binder) and electronic format.
   b. Organized with index, tabs, and updated record drawings.

2. As-Built Drawings:
   a. AutoCAD DWG/DXF and PDF formats.
   b. Updated schematics and wiring diagrams.

3. Final Software Deliverables:
   a. Fully annotated PLC application program.
   b. Register lists.
   c. I/O lists and Tag Lists (Excel format).

d. Operator interface (OIU/OIT) configuration files.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Provide in accordance with Section 01 78 23 – Operation and Maintenance Data and this Section.

B. Include:

1. Contact information.

2. Final Bills of Material.

3. Manufacturer literature and catalog cuts.

4. Final shop drawings, schematics, and connection diagrams.

5. Test and calibration reports.

6. Annotated software programs and Tag Lists.

C. Submit preliminary manual for review, then final corrected manual prior to Substantial Completion.

D. Provide all electronic deliverables on Owner-approved media.

1.06 FINAL SOFTWARE SUBMITTAL

A. Provide licensed, registered copies of all required software in Owner's name.

B. Deliver development and runtime software with full documentation.

C. Submit annotated, as-built PLC programs and operator interface configuration.

D. Provide all required media, manuals, and keys for future use by Owner.

1.07 SOURCE QUALIFICATIONS

A. PCS Integrator shall be a single entity responsible for complete PCS performance and shall have a record of working with Santa Fe County for over 15 years.

B. PCS Integrator shall have experience with and a thorough knowledge of Santa Fe County standards and operational criteria.

C. Acceptable Integrators:

1. Yukon & Associates, Albuquerque, NM.

2. I&C Solutions, Albuquerque, NM

3. Or Engineer-approved equal meeting qualification criteria.

D. Integrator qualifications: minimum three similar projects, control panel fabrication, PLC programming, OIS development, and field support.

1.08 SYSTEM INTEGRATION REQUIREMENTS

A. Provide complete, operable PCS including all required hardware, software, and services.

B. Coordinate all submittals, wiring, and protocols for seamless system operation.

C. Provide necessary cabling (CAT6, fiber optic) for communication networks.

D. Verify interoperability of PCS components and third-party systems.

E. Perform complete testing and commissioning per Section 40 80 00.

1.09 WARRANTY

A. Provide 1-year warranty commencing at successful PCS commissioning.

B. Response times:

1. Software: remote troubleshooting same or next business day; on-site service if unresolved.

2. Hardware: on-site service within two (2) business days.

C. Provide written service reports for all warranty actions.

D. Offer ongoing maintenance agreement to Owner at end of warranty period.

1.10 SOFTWARE PACKAGES

A. Register all required software in Owner’s name.

B. Provide licenses, warranties, and upgrade eligibility.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide products and materials in accordance with referenced Sections.

B. Provide additional materials necessary for complete PCS.

PART 3 EXECUTION

3.01 SCOPE OF SUPPLY

A. Provide materials required by:

1. Section 40 63 43 – PLC Systems.
2. Section 40 67 10 – Control Panels.
3. Section 40 68 13 – Human Machine Interfaces.
4. Section 40 72 76.13 – Liquid Level Float Switches.
5. Section 40 78 59.13 – DC Power Supplies.
6. Section 40 78 10 – Control Hardware.

B. Provide services required by:

1. Section 40 60 10 – Instrumentation Testing/Calibration.
2. Section 40 60 20 – Control Circuits Testing.
3. Section 40 61 96 – Process Control Descriptions.
4. Section 40 80 00 – PCS Commissioning.

3.02 PROGRAMMING

A. Develop, test, and implement PLC and OIS programs per Section 40 61 96 – Process Control Descriptions.

B. Provide annotated logic and operator interface screens.

3.03 FIELD SERVICE REPRESENTATIVE

A. Field service representative shall be NICET Level 3 Certified Control Systems Technician or Licensed Professional Engineer (EE/Controls).

B. Provide minimum on-site services:

1. Construction Assistance – 2 days.
2. Testing/Commissioning – 10 days.
3. Training – 2 days.
4. Post-Occupancy Support – 1 day, approx. 8 weeks after beneficial occupancy.

C. Training:

1. OIT operation and navigation.
2. OIU use, trending, reporting, and data export.
3. Alarm handling and event logging.
4. Use of Excel-based reporting tools.

END OF SECTION

SECTION 40 61 93

INSTRUMENTATION AND CONTROL WIRING SCHEDULE AND I/O TAG LIST

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Instrumentation and Control (I/O) Wiring Schedule.

B. Tag List.

1.02 SUBMITTALS

A. The Engineer will furnish the Wiring Schedule and Tag List to the Contractor in Excel™ format upon request.

B. Add columns to the file to show programmable logic controller (PLC) input and I/O point assignments. Initially submit in paper format.

C. After the submittal is accepted, furnish a copy of the Excel™ file to the Engineer in Excel™ format.

D. Maintain the Tag List so it is current with changes made during construction. In the header or footer place “Record Version” or similar.

E. Submit paper and electronic copies of the final Record Version.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MINIMUM REQUIREMENTS

A. The instruments, points, tags, inputs, outputs, and similar shown on the appended Tag List are minimum requirements. Provide others as shown on the Drawings. Provide additional spare inputs and outputs as specified in the control system hardware specification.

B. See all Electrical 800 series Drawings for Instrumentation and Control Wiring Schedule and I/O Tag List.

END OF SECTION

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for control and monitoring of system processes and equipment typically implemented in PLC Software.

B. Related Operator Interface Unit and Operator Interface Terminal software requirements.

C. Certain setup and calibration requirements.

1.02 SUBMITTALS

A. Submit as described under Section 40 61 13 – Control System Documents and Procedures.

1.03 OPERATIONS AND MAINTENANCE DATA

A. Submit as described under Section 40 61 13 – Control System Documents and Procedures.

B. Provide a complete version of the control sequences which describes actual control of the process and equipment at the time the Owner takes possession of the site. Do not provide a document which shows only the differences between an original version and the final version. Upon request, the Engineer will furnish this Section to the Contractor as an electronic Word™ document. By making this request, the Contractor agrees to use the document only for the purposes of this Contract and agrees that his subcontractors and other agents agree to the same.

C. The Sequences of Operations described below are not inclusive of all system functionality details that need to be programmed into the PLC and OIT. There will inevitably be changes and additions to these sequences as the implementation of the new control system progresses.

1.04 MISCELLANEOUS ABBREVIATIONS

A. ATS – Automatic Transfer Switch.

B. CFNR – Called for but Not Running (alarm).

C. FVNR – Full Voltage Non-Reversing (starter).

D. FVR – Full Voltage Reversing (starter).

E. HOA – Hand-Off-Auto Switch.

F. HMI – Human Machine Interface Software.

G. I/O – Input/Output.

H. MPR – Motor Protection Relay (relays provided with certain submersible motors).

I. OIT – Operator Interface Terminal such as a panel mounted touchscreen.

J. OIS – Complete Operator Interface System including servers, workstations, OITs, hardware and HMI software, if applicable.

K. OIU – Operator Interface Unit such as an Operator Workstation, if applicable.

L. PLC – Programmable Logic Controller.

M. PRP – Protective Relay Panel.

N. VFD – Variable Frequency Drive.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SYSTEM CONSIDERATIONS

A. See 40 61 93 – Instrumentation and Control Wiring Schedule and I/O Tag List and the 800 series Drawings for PLC wiring connections.

B. The 02-LSCP Operator Interface Terminal (OIT) on the inside swing out door of the PLC enclosure shall connect to the PLC and shall display functionality and information programmed into the PLC. This shall include all alarms, equipment status, and operator introduced control functions as called out in paragraphs below and shown on the I/O Tag List.

3.02 SYSTEM ADJUSTMENTS

A. During setup and construction, all adjustments to timers, alarm setpoints, trigger setpoints, instrument ranges, etc., shall be made by a qualified PLC programmer using a laptop with the required PLC interface software installed. Changes to these values from the OIT shall only be allowed by an operator with a P2 password once the system has been turned over the Owner.

B. PLC shall be programmed to <u>not</u> accept time or analog settings that the operator attempts to enter if they are not within the ranges shown in specific sequences.
1. For non-process timers, assign a logical range for ranges not shown.

2. For process timers and analog set-points, submit a list of ranges for approval by Engineer.

C. Assume that every process timer setting, every analog set point, and approximately 20% of the non-process timers may have to be adjusted during system startup.

3.03 PROCESS VARIABLES

A. Where "instantaneous" values are required, provide a sliding average window for every analog input with an adjustable sample rate and an adjustable window time. Start with 1-minute windows, taking a sample each 6 seconds. Adjust during startup as recommended by the programmer and agreed to by the Engineer.

B. Scale mA signals in the PLC where received.

C. Provide a summary OIT screen that shows the instantaneous value of each analog process variable. Also show totalized quantities. If a single screen does not easily accommodate all values, provide multiple pages.

3.04 EQUIPMENT STATUS, RUN TIMES

A. In the PLC, totalize and store all run times required for pumps and other operating equipment.

B. Show Run, Stop, and Alarm state of each equipment item on the OIT by color.
1. RUN shall be Green
2. STOP or OFF shall be Red.
3. ALARM shall be Yellow.

C. Show each run time adjacent to the respective process equipment symbol on the OIT.

D. Provide means so the Operator can create a display which shows a history of when a motor or set of motors was running versus stopped over an adjustable period of time.

3.05 GENERAL ALARM AND EVENT REQUIREMENTS

A. For Each Alarm:
1. Process the alarm condition in the PLC of the respective control panel.
2. Do not allow loss and/or restoration of plant power to create false occurrences of alarms.
3. Display the alarm on the OIT.
4. Log the alarm in both the Event and Alarm Logs.
5. Sound horns as specified below if one is included.
6. Provide "Acknowledge" function on OIT screen. When an alarm is acknowledged by the Operator, change alarm to acknowledged and silence the horn (if applicable).
7. Provide "Silence" function on OIT screen and by hardware buttons where shown. When an alarm is silenced by the Operator, silence the horn but do not acknowledge the alarm.

8. If an alarm condition has been cleared and acknowledged, remove it from the alarm screen. A few alarms, as specified below, do not clear until after the operator presses a hardware reset button.
9. Sound each alarm on PLC panel, continuously, until the Operator presses Acknowledge or Silence.

B. Sound Horn(s) as Follows:
1. If a horn is included as part of the project as shown in the Contract Drawings or as identified in the Tag List, provide a means of setting:
2. Sound horn for each alarm unless specified otherwise below.
3. Sound horn(s) for 15 seconds initially then for 2 seconds every minute until Operator presses Acknowledge or Silence. Silence if the real time runs into non-work hours or a holiday period.

C. In many of the specific equipment sequence descriptions, the word “display” is used for a shorthand reference to an alarm. Interpret that as requiring all details of alarm processing.

3.06 SOFTWARE TIMERS

A. Where a sequence calls for software timers, provide the corresponding software as indicated below.

B. Time of Day Timer Requirements:
1. Provide multiple starts per day, based on real time of day. The required number of starts per day for a given system is shown in specific sequences.
2. Provide an independent run time setting for each start time.
3. Provide table to allow setting of start times using military time notation (hours and minutes, no seconds) and associated run times using minutes and tenths of minutes.
4. Enter 1200 for noon. Enter 2400 for midnight. Enter zero to avoid operation.
5. Do not accept settings with a zero run time corresponding to a positive start time.
6. If a run time setting from some start time overlaps one or more other start times, run during the entire first run time and ignore the run times of the start times which have been overlapped.

C. Repeat Cycle Timer:
1. Provide for on-time and off-time which repeat without regard for time of day.
2. Provide two adjustment points on an OIT screen, in units stated in specific sequences.
3. Provide the timing ranges stated for each timer required in specific sequences.
4. Do not allow the entry of negative numbers.
5. Do not allow the entry of a setting equal to the range. This is different from other timers, which do not allow settings greater than the range.

D. Interval Timer:
1. Provide delay after initiation. For timers which provide delay of recognition of field inputs, such as starter auxiliary contacts and floats, reset the timer

immediately if the field contact resets. Some timers referred to as interval timers might actually be one-shot timers, such as to provide a momentary closure to start a motor with three-wire control. Some interval timers must reset themselves, with delay, therefore being repeat cycle timers. Some interval timers, must reset themselves or be reset by other logic, resembling a repeat cycle timer with no "off" time.

2. Provide for adjustment on the OIS, in units stated in specific sequences.
3. Provide the timing ranges stated for each timer required in specific sequences.
4. Do not allow the entry of negative numbers.

3.07 GENERAL REQUIREMENTS FOR CONTROL OF A MOTOR

A. Do not allow a motor to start that has a current alarm. Current alarm means an alarm whose field condition has not been cleared. In some cases, as required in specific sequences, do not attempt to start the motor until the operator has pressed the reset button.

B. Motors with Two-Wire Control (One PLC output):
1. When the set of conditions occurs that will call for a motor to run, energize the run relay.
2. When the set of conditions occurs that will call for a motor to stop, de-energize the run relay.

C. Motor with Communication Protocol Control:
1. When the set of conditions occurs that will call for a motor to run, send a start command over the communication protocol.
2. When the set of conditions occurs that will call for the motor to stop, send a stop command over the communication protocol.
3. If communications is lost, program the respective equipment (overload relay, VFD, valve actuator, etc.) to respond as specifically called out in the respective sequence.

3.08 EQUIPMENT ALTERNATION

A. Refer to the specific sequence for alterations or additions to the following. Use actual names in place of "Equipment" below.

B. Equipment Selection Options:
1. Lead.
2. Lag1, Lag2, Lag3, etc.
3. Standby.
4. Offline.

C. Pumps in an alarm condition shall not be able to be selected for Lead or Lag. Only as Offline.

D. Offline Pumps does not operate under automatic operations and shall remain as Offline until an Operator reassigns it to another position.

E. Alternation: Show which state is currently selected and provide software selection of the following choices on the OIS.
   1. "Always Lead."
      a. Allow Operator to select the Pump as Lead, Lag, etc.
      b. Operator should always be allowed to select The Pump as Offline.
      c. Selected "Always Lead" Pumps should always lead. The alternative pump will only start if additional capacity is required or if the Lead Pump fails.
      d. If Lead Pump fails then alarm, change the Lead to Offline, and Change Lag to Lead. Resume operations on new assignment.
   2. "Alternate."
      a. Allow Operator to select the Pump as Lead or Lag.
      b. Operator should always be allowed to select Pump as Offline.
      c. When conditions call for the operations of the Pump, began operations with the Lead. Additional Pumps will only start if additional capacity is required or if the Lead Pump fails.
      d. When The Pumps stop then alternation takes place. Lead moves to the last Lag position and the Lag pump switches to Lead position.
      e. If Lead Pump fails then alarm, change the Lead to Offline, Change Lag to Lead, and so forth. Resume operations on new assignment.

F. Except where required in a specific sequence, perform alternation after the stop of the Pumps.

G. Except where required in a specific sequence, do not automatically start more than one Pump at a time and do not automatically start additional Pumps with one already running in hand.

H. Except where required in a specific sequence, do not allow for the selection of multiple Pumps for the same selection.

3.09 COMMON EQUIPMENT FUNCTIONALITY

A. Common functions are generally applicable to all loops or to many similar loops. These functions are not repeated in the descriptions for each individual control strategy. The descriptions for equipment requiring specific functionality are described under the heading "EQUIPMENT RELATED CONTROL STRATEGY DESCRIPTIONS" addressed below.

B. All system functions shall be provided by PLC programmed control logic. The Contractor shall employ experienced PLC programming personnel to provide 24-hour assistance for all controller and programming needs during the commissioning and warranty periods.

C. The following terms are used in the descriptions of PLC functions:
   1. Operator Settings: Operator set or entered values shall be constants that are adjustable or set from operator displays. Examples of operator set or entered values are controller set points, batch set points, etc. Specific values that are required to be operator set are noted in the Equipment Related Control Strategy Descriptions that follow.

2. Tunable Values: Tuning constants for PID controllers are only adjustable at the engineer level without requiring any software reconfiguration. These values shall not be adjustable from operator accessible displays.

D. The following general control system functions shall be provided:
1. All analog and discrete inputs to the PLC shall be available to the OIT. Both Pump RUN and Pump OFF input states shall be recorded and displayed.
2. All analog inputs shall have instrument failure alarms when the input is below 0 percent or above 100 percent of calibrated range for a tunable time initially set at 10 seconds.
3. All discrete FAIL inputs shall be alarmed. Other discrete inputs shall be alarmed as noted in the Equipment Related Control Strategy Descriptions.
4. All local alarms shall be monitored by the PLC software, but some of those alarms may be incorporated into common alarms as indicated.
5. PLC software alarms and interlocks are alarms or interlocks that are generated by the PLC program based on logic from one or more parameters that are monitored by the PLC.
6. Where alarms are specified in the Equipment Related Control Strategy Descriptions, alarms shall be initiated from the applicable inputs. If discrete inputs are not available, the specified alarms shall be initiated from the applicable analog input; alarm setpoints shall be operator adjustable.
7. All analog and discrete signals that generate alarm and shutdown functions shall incorporate a 0- to 300-second adjustable time delay before activating to assist in reducing or eliminating nuisance alarms.
8. All pulsed flow inputs and equipment run times shall be totalized in the PLC program and shall be properly recorded. All totalized values shall be available to the OIT.
9. Displays shall be grouped functionally for ease of viewing and operation. Both analog and discrete functions associated with an item of equipment or a group of equipment shall be provided on the same display.
10. Unless otherwise stated or shown, all discrete outputs shall be maintained outputs. For START/STOP PLC functions, the PLC shall issue a maintained START command until a FAIL state is detected or when a STOP command is issued. When a momentary command is required, the PLC shall issue the command for 2 seconds, then remove the signal.
11. For equipment that is controllable from the PLC, a control mode status signal shall be sent to the PLC to indicate when the PLC is allowed to control the equipment. The PLC shall monitor the control mode status (LOCAL/ REMOTE or HAND/OFF/AUTO) and attempt to control the equipment only when the system is in the REMOTE or AUTO mode.
12. For ALL equipment that the PLC is allowed to control, the PLC shall provide a FAIL alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than an adjustable time period. In this event, the command shall be removed until the system can be reset by the operator at the local site.

13. For equipment that is controllable from the PLC in either a MANUAL or AUTOMATIC mode, the operator shall be provided with a software AUTO/MANUAL selector switch at the operator interface panel. Transfer between the MANUAL and AUTOMATIC modes shall be bumpless.
14. For all equipment for which RUN status is monitored by the PLC, provide run time totalizers in the PLC program which can be reset when desired by the operator.
15. All PID control functions (P, PI, and PID) shall be provided with standard analog controller functions and operator interfaces including, but not limited to, the following:
    a. AUTO/MANUAL mode selection: In AUTO, the output of the controller shall be based on the PID control algorithm. In MANUAL, the output of the controller shall be operator adjustable. Transfer between operational modes shall be bumpless.
    b. LOCAL/REMOTE setpoint selection: In LOCAL, the set point shall be operator adjustable from the equipment. In REMOTE, the setpoint shall be adjustable from a REMOTE set point input at the operator's control room or workstation.
    c. Setpoint, process variable, and controller output shall be displayed.
    d. Provisions shall be included to prevent reset windup.

3.10 EQUIPMENT RELATED CONTROL STRATEGY DESCRIPTIONS

A. General System Integration
1. All hardwired connections to the PLC on this project are shown on the Series 800 Drawings for each system. All status and alarm information, start/stop and open/close commands, analog input and output data shall be made accessible to the operator on the OIT. PLC programmed functionality is described in the sections below.

B. Lift Station Pumps:
1. The PLC to be furnished and installed as 02-LSCP shall be used to interface the I/O connections to the pump VFDs and to level sensing instruments and equipment as called out on Sheets E-801.
2. Float switches shall be installed in the wetwell and shall open/close a contact at the levels shown on Sheet W-106. These floats shall be used as a backup to pump operation controlled by the ultrasonic level transmitter, 02-LIT201. Levels for turning on and turning off the pumps based on signals from the level transmitter shall be as follows:
    a. Lead Pump Start – 2 inches *below* the level indicated for the LEAD PUMP START float switch activation.
    b. Lag Pump Start – 2 inches *below* the level indicated for the LAG PUMP START float switch activation.
    c. All Pumps Stop – 2 inches *above* the level indicated for the ALL PUMPS STOP float switch activation.
    d. High-High Level Alarm – 2 inches *below* the level indicated for the HIGH WATER ALARM float switch activation.

3. Program the PLC to turn on the Lead Pump when the designated level is reached in the wetwell as sensed by the ultrasonic level transmitter. If the level continues to rise, turn on the Lag Pump at the proper level.
4. With two pumps running, they should be programmed to pump the level down until the ALL PUMPS STOP level is reached. If two pumps cannot keep up or if there is a problem where one of the pumps is not operating properly and the level keeps rising, activate the Alarm Beacon and sound the Alarm Horn as called out in this specification, Section 3.05, when the HIGH WATER ALARM level is reached.
5. Program the PLC to use the level transmitter as the primary source of pump operation. Should there ever be a problem with the level sensor, the floats should be programmed to operate as backup.

C. Pump Sequence of Operation:
1. When all the features of the lift station are in operation (alternation, pump failover, instruments, etc.) are all working, the following sequence of operation shall be implemented when the system is in the Auto Mode:
   a. During normal operation, the pumps shall operate in the pump-down sequence as called out in Section 3.10, B above. When the wetwell fills to the LEAD PUMP START level, the PLC shall initiate the Lead Pump VFD and ramp to a pump speed that corresponds to 800 gpm, as measured by 02-FIT101, until the level drops to the ALL PUMPS STOP level where the PLC then removes the run signal from the VFD.
   b. Should there be a time when one pump cannot keep up and the wetwell level rises to a point where the LAG PUMP START setpoint is activated, the PLC program shall initiate the VFD on the Lag Pump and ramp both pumps to a total flowrate of 1,600 gpm, 800 gpm from each pump, with both pumps being called to operate at equal speeds. Both pumps will be called to stop when the ALL PUMPS STOP level is reached and the PLC then removes the run signal from the VFD.
   c. Once a day at a peak influent flow time selected by the operator, say around 7:00 AM, the pumps will be called to operate in the SCOUR FLOW MODE to resuspend solids accumulated in the sag portion of the forcemain. In this mode, the PLC shall call for two pumps to start when the LEAD PUMP START level is reached and the VFDs shall ramp to a total flowrate of 1,000 gpm with both pumps called to operate at the same speed. The pumps shall remain in this state until the ALL PUMPS STOP level is reached and then shut off. This mode shall only be initiated once per day and only last for this one cycle.

D. Flow Monitoring:
1. The flowmeter, 02-FIT101, shall be furnished and installed as shown on the drawings with the flow transmitter mounted inside the PLC panel, 02-LSCP. The flowrate signal from this flowmeter shall be displayed on the front of the transmitter and on the OIT. The flowmeter shall also provide a pulsed signal representing TOTAL FLOW which shall also be displayed on the transmitter and the OIT.

E. Lift Station LS1/LS2 Enable Switch:

1. The PLC Panel, 02-LSCP, shall come with a selector switch mounted to the front of the interior swing-out door which will allow the operator to choose which lift station is to operate. If "LS1 ENABLE" is chosen, the existing lift station will be allowed to operate on Auto and the new lift station will be disabled from operation. If "LS2 ENABLE" is chosen, the new lift station will be placed into operation and the existing lift station operation will be disabled.

3.10 TESTING AND TRAINING

A. See Section 40 61 13 – Control System Documents and Procedures.

END OF SECTION

SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLLER SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. Programmable Logic Controller (PLC) hardware and software.

B. Remote input/output (I/O) subsystems.

C. Communications networks and interfaces.

D. Network switches and cabling.

E. Human-Machine Interface (HMI) panels and software.

F. Integration with the Process Control System (PCS).

G. Accessories and incidental components necessary for a complete system.

1.02 RELATED SECTIONS

A. Section 26 00 60 – Extra Materials and Spares for Electrical Systems.

B. Section 40 61 13 – Control System Documents and Procedures.

C. Section 40 61 96 – Process Control Descriptions.

1.03 SUBMITTALS

A. Product Data:
1. PLC processor, chassis, power supplies, I/O modules.
2. HMI panel(s), software, and accessories.
3. Network switches and communication modules.

B. Shop Drawings:
1. Interior and exterior panel layouts.
2. Wiring diagrams including PLC I/O, AC/DC power, and grounding.
3. Nameplates and identification scheme.

C. Software Documentation:
1. Description of programming environment and version.
2. Licensing details, registered to Owner.
3. Source code and configuration files.

D. Evidence of Compliance: UL 508A certification, hazardous location rating, and manufacturer's support policy.

1.04 OPERATION AND MAINTENANCE (O&M) DATA

A. PLC Operator's Manual, including but not limited to:
1. Installation, startup, and shutdown procedures.
2. Troubleshooting guides and diagnostic functions.
3. Preventive maintenance requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Minimum 10 years' experience manufacturing PLCs.
2. Ability to provide long-term support and spare parts (minimum 7 years after purchase).

B. Control Panel: UL 508A listed, factory assembled and tested.

1.06 WARRANTY

A. Provide manufacturer's standard 1-year warranty, extendable to 2 years.

1.07 SYSTEM DESCRIPTION

A. Provide a complete PLC system as part of the Lift Station Control System, all factory assembled into enclosures, complete, and with all related materials and accessories. Supply incidental accessories to achieve a completely functional system, whether shown or not.

B. Design for and test to show correct function of PLC hardware and software, and correct interface between PLC, OIT, Network Switches and other equipment.

C. PLC Communications Capability:
1. Port for programming.
2. RS485 port.
3. Ethernet port.
4. As scheduled, as shown on Drawings, as needed for complete system implementation.

D. System Communications:
1. Use open, industry standard protocols, such as Ethernet Industrial Protocol, Modbus TCP, Modbus RTU or Engineer reviewed substitute.
2. Provide communications between the PLC and any Operator Workstations over CAT 6 cable using Ethernet, if applicable.
3. Provide other communications as required in Part 3 or on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Basis of Design: Allen-Bradley CompactLogix 5069 L330ER Series.

B. Acceptable Manufacturers:
1. Allen-Bradley/Rockwell Automation.
2. Engineer-approved equivalent.

2.02 PLC HARDWARE

A. Processor:
1. Memory capacity scalable from 64 KB to 7.5 MB.
2. Execution time ≤ 0.15 µs per bit instruction.
3. Supports online editing and runtime modifications.
4. Flash memory backup with removable media.

B. Input/Output Modules:
1. Digital I/O: 24 VDC discrete input and output.
2. Analog I/O: 4–20 mA isolated channels, 16-bit resolution minimum.
3. Hot-swappable, keyed terminal blocks.
4. Diagnostics for under/over-range and fault reporting.

C. Communication:
1. Ethernet/IP as primary protocol.
2. Support Modbus TCP/RTU via gateway module if required.
3. Minimum one USB programming port, one Ethernet port.

2.03 HUMAN MACHINE INTERFACE (HMI)

A. PanelView +, 10-inch color touchscreen, NEMA 12 rated.

B. Capable of displaying real-time process data, alarms, and manual control functions.

C. Program the plc OIT to interface directly with the plc and not to function as a network workstation.

2.04 NETWORK SWITCHES

A. Managed, industrial-rated, DIN-rail or panel-mount.

B. Minimum 8 × RJ-45 ports (10/100/1000Base-TX) plus fiber ports as required.

C. Basis of Design: Phoenix Contact, N-Tron, RedLion, or Engineer-approved equivalent.

2.05 SOFTWARE

A. Provide PLC development software package licenses.

B. Use it for development of the PLC program so the PLC provides controls and functions required under Section 40 61 96 – Process Control Descriptions.

2.06 EXTRA MATERIALS AND SPARES

A. See Specification 26 00 60 – Extra Materials and Spares for Electrical Systems.

2.07 SPARE I/O POINT QUANTITY

A. Provide inputs and outputs as shown in the Tag List, including those marked as spare in the Tag List. Provide additional spare points as required below.

2.08 OTHER COMPONENTS

A. Provide all required cables, cords, and connective devices for interface with other control system components.

B. Provide UPS for both PLC and Remote I/O control panels. Size each to provide one hour of operation under full-load conditions should a power outage occur. Program PLC to accept and display UPS alarms indicated on Tag List.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and UL 508A.

B. Provide proper grounding, shielding, and segregation of AC and DC wiring.

C. Maintain free airflow; do not install fans inside enclosures.

3.02 FIELD QUALITY CONTROL

A. Factory Acceptance Test (FAT) prior to shipment.

B. Site Acceptance Test (SAT) to confirm:
1. PLC program execution.
2. HMI screen operation.
3. Network communications.
4. Failover and power recovery.

3.03 I/O ASSIGNMENT

A. Assign inputs/outputs per I/O Tag List on Drawings.

B. Do not mix different neutral groups unless shown on Drawings.

END OF SECTION

SECTION 40 67 10

CONTROL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control panels.

1.02 NATIONALLY RECOGNIZED TESTING LABORATORY (NRTL)

A. Underwriters Laboratories, Inc. (UL), Electrical Reliability Services, Inc., Division of Emerson Electric, (ERS), or other organization that is recognized by the State of New Mexico and is acceptable to the Engineer.

B. NRTL is used below to refer to UL and/or ERS. Other organizations may request inclusion. Submit information minimum 10 working days before the Bid date for review by the Engineer. Include minimum 25-year company history, company qualifications similar to UL or ERS, a detailed description of the NRTL requirements which apply to a panel shop, including follow-up inspections, plus documentation showing recognition by the State of New Mexico. NRTL found to be acceptable will be added by addendum.

1.03 STANDARDS

A. For panels which will be installed in ordinary locations with an ambient temperature of up to 40°C, comply with the requirements of UL508A, Standard for Industrial Control Panels, latest edition.

B. For panels which will be installed in hazardous locations, comply with the requirements of UL 698, Standard for Industrial Control Equipment for Use in Hazardous (Classified) Locations, latest edition.

C. For panels which incorporate intrinsic safety barriers and are intended for connection to circuits residing in hazardous locations, comply with the requirements of UL 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations, latest edition.

D. UL 508A is used in Paragraph 1.04 to refer to UL508A, UL698, or UL698A depending on the type of panel. It is recognized that there may be standards similar to UL508A, UL698, and UL698A which are published by a NRTL not listed above. The Engineer will review such standards for acceptability only if a complete, original, current copy of both the UL standard and the proposed alternate standard are submitted a minimum of 10 working days before the Bid date. Also submit information about the NRTL itself, as required above. Standards found acceptable will be added by addendum.

1.04 MANUFACTURING AND LABELING

A. Provide control panels that are manufactured and labeled by a company which:
   1. Specializes in the manufacture of panels which are:
      a. Designed and manufactured to comply with the requirements of UL508A,
      b. Labeled to certify compliance with UL508A;
   2. Is currently and directly authorized by a NRTL to regularly apply labels of the NRTL which certify compliance with UL508A;
   3. Has successfully passed a factory inspection conducted by the NRTL Follow-Up Services, including inspection of NRTL-certified product then being manufactured, during the calendar quarter previous to or during the calendar quarter of the Bid Date and successfully passes all such inspections which may occur during the period of manufacturing of the panels for this project.
   4. Also specializes in the supply and startup of instrumentation and control systems.
   5. Has on staff a field service representative who is currently certified as a Certified Control Systems Technician, Level 3, by the National Institute for Certification in Engineering Technologies.

B. A control panel which is manufactured by a company which is not currently and directly authorized by a NRTL to regularly apply labels of the NRTL will not be acceptable, except as provided in Paragraph 1.04 D.

C. A control panel which is manufactured by a company which did not successfully pass a factory inspection conducted by the NRTL Follow-Up Services, including inspection of NRTL-certified product then being manufactured, during the calendar quarter previous to or during the calendar quarter of the Bid date or which does not successfully pass all such inspections which may occur during the period of manufacturing of the panel(s) for this project will not be acceptable except as provided in Paragraph 1.04 D.

D. A control panel manufacturer which would propose to provide panels which are labeled on a one-by-one basis by a NRTL may be acceptable. Submit information to the Engineer to show compliance with the following requirements a minimum of 10-working days before the Bid Date. Provide complete information in well-organized, indexed, tabbed ring binders. Lack of compliance with the previous sentence will be a basis for rejection. Insufficient or confusing information will be a basis for rejection. No subsequent information for purposes of this paragraph will be requested or accepted. Nothing will be returned. A manufacturer found to be acceptable will be added by addendum.
   1. Requirements for an acceptable control panel manufacturer:
      a. Company specializes in the manufacture of panels which are designed and manufactured to comply with the requirements of UL508A and labeled by the proposed NRTL to certify compliance with UL508A. Provide a list of at least 20 such panels, giving project name, panel name, and description of function of panel.

b. Company specializes in the supply and startup of instrumentation and control systems. Provide a list of at least six projects for which the company supplied and started up the complete instrumentation and control system. Include name of owner, name of project, name of installing contractor, name of prime contractor, and name and telephone number of a contact of each above organization.

c. Company has on staff a field service representative who is currently certified as a Certified Control Systems Technician, Level 3, by the National Institute for Certification in Engineering Technologies. Provide a copy of the certificate.

d. Company understands requirements of the Specifications for this project related to submittals and O&M Manuals. Provide a sample submittal package and a sample O&M Manual, addressing each particular element of the Specification requirements.

2. Also provide standard, published information about the inspection and labeling process used by the NRTL and a copy of three different, specific reports prepared by the NRTL as a result of having labeled panels for the proposed panel manufacturer. Delete or change information as needed in order to conceal the identity of the owner of the subject panel.

1.05 SUBMITTALS

A. For a company which complies with the requirements of Paragraphs 1.04 A. 2. and 3., provide a certificate from the NRTL showing such compliance. For a company added under the provisions of Paragraph 1.04 D., provide two additional sets of the information provided in response to the requirements of Paragraphs 1.04 D. 1. a., b., and c. and 1.04 D. 2.

1.06 OPERATION AND MAINTENANCE DATA

A. Provide a complete set of wiring diagrams and panel layout Drawings including panel dimensions and applied nameplates.

1.07 EXTRA MATERIALS

A. Relays: Minimum two of each type but more if required in other Sections.

PART 2 PRODUCTS

2.01 ENCLOSURE

A. Section 26 27 16 – Cabinets and Enclosures.

B. If so scheduled, shown on the Drawings, or required in other Sections, provide a Lexan™ window in the door of a control panel:

1. Construct as to preserve NEMA rating of enclosure.
2. For a PLC or other type of controller/RTU, locate so diagnostic and indicator lights on face of PLC are easily visible.

3. All PLC panels shall be furnished with a pocket on the inside of the door to hold documents and schematic drawings and a folding tray to hold a laptop computer when the PLC programmer is performing testing.
4. All panel enclosures shall include an LED light on the ceiling of the panel that illuminates when the doors are opened.
5. Enclosures shall be Hoffman, Rittal, Saginaw or Engineer Approved Equivalent.

2.02 CABINET COOLERS

A. Provide one or more coolers in a given Control Panel if:
1. The schedule calls for coolers, or
2. A component having an ambient temperature rating that is 2°C lower than other components is furnished, or
3. The panel manufacturer recommends coolers.
4. Panels with coolers are indicated on the Drawings.

B. Cooler Requirements:
1. Two fans, each minimum 215 CFM and rated for 10 years of life.
2. Sealed heat pipes rated for 30 years of life.
3. Air exchange between enclosure and external environment not allowed.
4. Designed and installed to preserve the NEMA Rating of the panel and to have the same NEMA Rating as or better NEMA Rating than the panel.
5. Models available rated from 16.5W per °C ▲T up to 110W per °C.
6. Rated for operation in ambient temperatures from -40° to +70°C.
7. Size the cooler to extract heat from the panel at a rate sufficient to prevent the panel interior from being more than 6°C higher than the local ambient.
8. Minimum Manufacturer's Standard Warranty: 4 years.
9. Cooler shall be Hoffman, Rittal, Saginaw or Engineer Approved Equivalent sized to keep Control Panel at a maximum of 70°F.

2.03 GROUND BARS

A. Enclosure Ground Bar:
1. Tin-plated copper.
2. Solidly bond to enclosure.
3. Use for connection of:
   a. Grounding electrode conductors.
   b. Equipment grounding conductors.
   c. Other grounds not connected to the Shield Ground Bar.
4. Provide separate screw, bolt, or terminal point for connection of each conductor.

B. Shield Ground Bar:
1. Tin-plated copper.
2. Mount on standoff insulators, close to and parallel to Enclosure Ground Bar.
3. Use for connection of shields of TWSH cable carrying analog signals to ground. Connect shield to terminal board point adjacent to the signal conductors. Connect from there to Shield Ground Bar with green, stranded #14.

4. Provide separate screw, bolt, or terminal point for connection of each conductor.
5. Connect Shield Ground Bar to Enclosure Ground Bar with two #10 stranded at each end four total. Arrange these connections for easy removal and replacement for purposes of testing.

2.04 PANEL ALARM HORN

A. Where and if designated, provide steady-tone piezoelectric alarm horn in control panels as scheduled or shown on the Drawings.

B. Sonalert or ENGINEER approved equivalent.

2.05 SWITCHES, PUSHBUTTONS, PILOT LIGHTS

A. Comply with Section 40 78 10 – Control Panel Hardware.

B. Provide engraved legend plates for switches, pushbuttons, and pilot lights. Text as shown on Drawings. If not shown, show on Submittals.

2.06 PANEL HEATER

A. For all panels which include electronic devices and components (particularly PLC and VFD panels), provide a thermostat adjustable panel heater sized to maintain the temperature on the inside of the panel above 35°F.

2.07 CONTROL COMPONENTS

A. Provide 120VAC to 24VDC power supply sized to accommodate anticipated DC power requirements. Connect to UPS to provide backup power to PLC and other control voltage components.

B. See 40 78 59.13 – DC Power Supplies.

C. Section 40 78 10 – Control Hardware.

D. As shown on the Drawings.

2.08 NAMEPLATES

A. Section 26 05 53 – Electrical Identification.

B. Furnish the following nameplates (NP):
1. Main NP:
   a. Black with 1/2" white letters.
   b. Text as on Drawings.
2. Component and device NP (internal):
   a. Adjacent to each terminal board, switch, pushbutton, pilot light, control component, and the like.

b. Black with 1/8" white letters.
c. Text: Same as on schematic.

3. Warning NP:
   a. On panel front.
   b. Red with 1/4" white letters.
   c. Text: WARNING. THERE MAY BE VOLTAGE IN THIS PANEL FROM MULTIPLE SOURCES.
4. Panel front indicating and display devices:
   a. Provide for each panel front mounted meter, recorder, and the like.
   b. Black with 1/4" white letters.
   c. Text: Same as on Drawings.
5. As called for on the Drawings.

2.09 TERMINAL BLOCKS

A. Section 26 27 27 – Wire Connectors and Accessories.

2.10 INCOMING POWER

A. Where hard-wired, connect to terminal blocks.

B. Provide a 120VAC Uninterruptible Power Supply (USP) for the MPCP panel and for the Remote I/O panels. Size according to connected load. See Section 26 33 53 – Static Uninterruptible Power Supply.

C. Where AC power comes from a UPS which is external to the panel and which has receptacles for load connections, provide a SO cord with attachment cap. Provide strain relief connector with rubber bushing at penetration of the control panel enclosure wall.

2.11 FACTORY WIRING

A. Wire Type:
1. Internal AC Wire: MTW, THHN, THWN.
2. Analog Signal Wire: TWSH.
3. Other DC wire: TWSH, MTW, THHN, THWN.

B. Color Coding:
1. Neutral: white; Ground: green.
2. 480V Phases: Brown, orange, yellow (A, B, C, respectively).
3. 120/240V that is controlled by the panel: Black, blue.
4. 120/208V that is controlled by the panel: Black, blue, violet (A, B, C, respectively).
5. 120V that is used in control circuits:
   a. Where derived from a control power transformer in the panel whose primary is disconnected by an overcurrent device handle on the panel that is interlocked with the door: Red.
   b. Foreign source: Yellow.

6. 24 VDC: TWSH as required in Section 26 05 19 – Low Voltage Wire and Cables.

C. Except where fuses are shown on the Drawings, provide DIN-rail mounted circuit breakers (not shown on Drawings) for AC power to all devices requiring AC power.

D. Provide multiple TB points and route wire such that removing the power wiring to any given device does not interrupt HOT or NEUTRAL to any other device.

E. Do not make connections by means of wire nuts or other similar means of splicing. If a component is factory equipped with integral leads, provide terminal boards nearby rather than splicing onto the leads.

F. Make field connections to panels onto terminal boards, not to devices. Provide 25% spare terminals.

G. Label each terminal board.

H. Mark each terminal board (TB) point. Use numbering as shown on Drawings. Where not shown on Drawings, assign a logical number. Submit to Engineer for review. Show all numbering on submittals.

I. Mark each wire end as follows:
1. Control conductors associated with MCC: Mark each conductor with tag number appended with MCC terminal point (i.e., M7101-X2).
2. Control conductors not associated with MCC: Mark each conductor with tag number and terminal board number. If conductor is routed between two devices without going to a terminal board, mark wire with tag number and an arbitrary number not used on terminal block.
3. Instrumentation (all ends of complete run of all digital and analog inputs and outputs to/from PLC whether in PLC, integrated control panels, termination panels, MCC, local control panels, or field device): Tag number. Also use black wire for + (plus) polarity and white for - (minus).
4. Show all wire numbering on submittals.
5. Marking Method: Section 26 05 19 – Low Voltage Wire and Cables.

J. Install wiring in plastic wiring duct.

K. Route analog wiring separately from all other wiring except DC Digital Inputs (DI).

L. Where wiring crosses a hinge or other flex point, bundle wires with plastic spiral wrap so bundles twist in a direction roughly parallel to hinge pin rather than folding or flexing perpendicular to hinged panel or door.

2.12 TRANSIENT VOLTAGE SURGE SUPRESSORS: SINE WAVE TRACKING, 120 VAC SINGLE PHASE, DIN RAIL MOUNT

A. UL labeled, showing compliance with UL 1449, Third Edition.

B. Features:
   1. Protection modes: line to neutral, line to ground, and neutral to ground.
   2. Green LED Status indicator and form C alarm contact.
   3. Sine wave tracking.
   4. Thermal fusing to prevent MOV overheating.

C. Ratings:
   1. Nominal Voltage: 120V, 1 phase, 3 wire.
   2. Continuous Current Rating: 20A.
   3. UL 1449, Third Edition, Suppressor Classification, 120 VAC normal/common mode: 400 VAC.
   4. Minimum peak surge current capability (8 X 20 ms):
      a. Line to Neutral: 10 kA.
      b. Line to Ground: 20 kA.
      c. Neutral to Ground: 10 kA.
   5. Noise Attenuation per UL 1283:
      a. Normal Mode: 50 dB, minimum.
      b. Common Mode: 40 dB, minimum.
      c. Let-through voltage of not more than 50V above the Sine Wave for Category A1 Ring Wave and not more than 500V L-N/900V L(N)-GND for a B3/C1 Impulse Wave.
   6. Maximum Continuous Operating Voltage (MCOV): 150V RMS. Control power transformers do not closely regulate the secondary voltage. Therefore, suppressors with lower MCOV may not function properly to protect these circuits.

D. Environmental:
   1. Temperature: - 40° to + 60°C.
   2. Humidity: 0% to 95%, non-condensing.

E. Physical:
   1. Steel case which mounts on 35mm DIN rail conforming to DIN EN 50022.
   2. Easily accessible, front-mounted screw terminals.
      a. Line Side: Hot, Neutral, Ground.
      b. Load Side: Hot, Neutral, Ground.
      c. Three for form C alarm contact.

F. Warranty: 10 years.

G. Phoenix Contact (www.phoenixcon.com) SFP SPD, Sola/Hevi-Duty (www.solaheviduty.com) STV25K-10S, or Engineer reviewed equivalent.

H. May or may not be shown on Drawings. Show in Submittal Drawings.

I. Install on each incoming AC circuit that is used for input to DC power supplies and/or other AC powered components, such as recorders.

J. Not required for:
1. Circuits which are not used for power in the panel, such as those switched to control a motor and those used as digital inputs.
2. Lighting, convenience receptacle, fans, heat exchangers.

2.13 DC CURRENT LOOP SPD (DCCL SPD)

A. SPD Proper:
1. Listed under UL 497B.
2. Two Part Design:
   a. Base terminal block which mounts to DIN rail.
   b. Plug-in surge protection module. Replacing a module shall not require the removal of any wires nor shall it interrupt the signal.
   c. Provide keying between base and plug to make sure that only the correct protection module will fit in the base.
3. Wiring Points and Plug Connections: "Touch safe" with no live voltages that can make contact with a misplaced finger in accordance with IEC 529.
4. Maximum Continuous Operating Voltage (MCOV): 28 VDC.
5. Surge protection module: Multistage hybrid circuit with staging inductors or resistors to properly coordinate the components; nominal resistance 10Ω.
6. Rated Continuous Operating Current: 450 mA.
7. Withstand a 10kA test current of a 8/20 µs waveform according to IEC 1024 Application Guide A and ANSI/IEEE C62.41 Category C Area.
8. Measured Response Time:
   a. L-L: Maximum 1 ns.
   b. L-GND: Maximum 100 ns.
9. Phoenix Contact PT Series, Edco PC-642 Series, or Engineer reviewed substitute.

B. Accessories:
1. 35mm DIN rail conforming to DIN EN 50022.
2. Terminal blocks for grounding of DCCL SPD.
3. Terminal block for carrying shield through ungrounded.
4. End stops; markers; nameplates.

C. Provide positive grounding of SPD assembly as follows:
1. Scrape the pan at the mounting points beneath the rail for good contact and bond the pan to the enclosure ground bar as specified above for the shield ground bar, using green #10 THWN at two places.
2. Attach a green/yellow ground terminal block to the rail and bond the rail to the enclosure ground bar with two #12.
3. Make no sharp bends in grounding conductors.

D. Be careful to install field conductors on the field side of the DCCL SPD and equipment conductors on the equipment side. Orient the DCCL SPD so field and equipment pairs do not touch each other.

E. Mark the SPD assembly and the terminal points on the DCCL SPD as required for terminal boards and terminal board points under Section 26 27 27 – Wire Connectors and Accessories.

F. The Drawings and/or the Tag List show field DCCL SPD. Provide all such SPD under this Section for field installation, in enclosures, and complying with the installation requirements above.

G. For each loop which has a field DCCL SPD, provide one in the control panel for that loop, whether shown on the Drawings or not. Show field and panel-mounted devices in submittal Drawings.

H. DCCL SPD which are not part of a larger control panel and/or not detailed elsewhere:
1. NEMA 4X SS enclosure with bare SS mounting pan.
2. Connect the SPD grounding screws to the ground bar (if present in the enclosure), a conduit bonding clamp (if lacking a ground bar), or other solidly grounded point (if lacking the previous grounds) with green #10 THWN. Make no sharp bends in grounding conductors.
3. Also comply with the requirements of Paragraphs B. through E., above.

2.14 OVERCURRENT AND SHORT CIRCUIT PROTECTION

A. Fuses:
1. Section 26 28 13 – Low Voltage Fuses.
2. Use Only:
   a. Where called for on the Drawings.
   b. Where recommended by the manufacturer of a specific piece of load equipment.
   c. If required in order to facilitate UL listing of panel.

B. AC Circuit Breakers:
1. Listed/labeled under UL 489 with 10kA interrupt rating at 120 VAC.
2. 120/240 VAC, 60 Hz. Do not use for DC circuits.
3. DIN rail mount; toggle for On/Off/Reset; available in 1, 2, and 3 pole.
4. Trip-free thermal-magnetic trip unit with time/current characteristics:
   a. 50 to 100 seconds at 2 times rated current.
   b. 3 to 10 seconds at 5 times rated current.
   c. Instantaneous at 8 to 10 times rated current.
5. ABB S200U series, or equivalent.

C. DC Circuit Breakers:
1. UL Recognized component with UL 1077 2kA interrupt rating at 65 VDC.
2. Use for 24 VDC applications only.
3. DIN rail mount; toggle for On/Off/Reset; use only single pole breakers.
4. Trip-free thermal-magnetic trip unit with time/current characteristics:
   a. 20 to 150 seconds at 1.5 times current.
   b. Instantaneous at 2 to 4 times rated current.
5. Phoenix Contact TMC-1 series, or equivalent.

D. Provide circuit breakers where shown on the Drawings. Also provide other breakers, as follows, which are typically not shown in the Drawings. Show in Submittals Drawings.
   1. DC circuit breaker, 0.2A, in the source for each 4-20 mA analog loop which is powered from a control panel. Mount CB on the DIN rail adjacent to the respective DCCL SPD assembly.
   2. AC circuit breaker of appropriate size for each AC device in a control panel, such as on the input of a DC power supply.

2.15 FACTORY TEST

A. Perform a factory test on each contractor furnished control panel.

B. Perform tests required for compliance with UL standards.

C. Verify correct calibration of all analog instruments and indicators.

D. Test complete hardware system including relays, timers, hand controls, indicators, instruments, and other active components.

E. For PLC Type Control Panels:
   1. Verify that opening and closing system inputs activates the correct PLC Discrete Input points (DI).
   2. Verify that signals from analog devices establish the proper 4-20mADC signal on Analog Input points (AI).
   3. Verify that simulated operation of PLC outputs produces the correct hardware actions.
   4. Test all software to verify that it functions as specified.

F. Verify correct communications with the operator interface system. Verify correct operation of software in conjunction with PLC software.

G. Verify that telemetry hardware and radios function properly.

H. Record test results and submit prior to installation of panel in field.

PART 3 EXECUTION

3.01 FIELD WIRING

A. Mark each field wire end except on twisted, shielded pairs, mark jacket, not individual wires.
   1. Text: As shown on submittals.
   2. Method: Section 26 05 19 – Low Voltage Wire and Cables.

B. Contractor to provide control panels, including, but not limited to, the following, that comply with this Section, with related Sections, and with the Drawings. Packaged system panels are not included in this list. Certain panels are specified to be furnished under process equipment Specification Sections. All such panels are required to meet the requirements of this Section, whether listed below or not.

1. Factory Witness Test for those control panels mark for witness test above.
2. Provide 8 hours for software modifications.
3. Arrange schedule with Engineer minimum 5 working days in advance.
4. Conduct testing in Albuquerque, New Mexico. Alternate: Pay transportation, lodging, and meal costs for one employee of the Owner and one employee of the Engineer if testing is not in Albuquerque, New Mexico.

3.02 SCHEDULE

A. Panels shall be constructed with outer door and interior swing-out door. Mount pushbuttons, pilot lights, selector switches, and touchscreen OIT on interior door as shown on Drawing E-502.

B. Panels shall also conform to the following:

Equipment Name	NEMA Enclosure Type	Cooler Required	Panel UPS Required	Include Intrusion Switch	Include Temp Switch	Include Network Switch
PLC Control Panel: 02-LCP	4X	Yes	Yes	Yes	Yes	Yes
VFD and Power Dist. Panel: 02-VFDP	4X	Yes	No	Yes	Yes	No

END OF SECTION

SECTION 40 71 13.13

INLINE ELECTROMAGNETIC FLOW METERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electromagnetic flow meters and accessories.

B. Documentation.

C. Startup, training, and other services.

1.02 SUBMITTALS

A. Standard manufacturer’s literature showing compliance with the Specifications.

B. Dimension Drawings of each size of flow element.

C. Dimension Drawing of flow transmitter.

D. Installation Manuals.

1.03 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Manufacturer's standard O&M manual.

B. Warranty letter which lists the serial number of each flow element and each flow transmitter and states the day of expiration of the warranty for each item of equipment.

PART 2 PRODUCTS

2.01 ELECTROMAGNETIC FLOW METERS – GENERAL

A. Furnish all electromagnetic flow meters for this project from a single manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service. Meters to be designed, manufactured, and calibrated in an ISO9001, NAMAS, NIST, NATA certified facility.

B. All electromagnetic flow transmitters furnished shall be fully interchangeable with all electromagnetic flow elements furnished.

C. Measuring Method: Low frequency pulsed DC coil excitation, potential electrodes, and high impedance amplifier.

D. Furnish a complete system for each electromagnetic flowmeter, including as a minimum a flow element, a flow transmitter, and the appropriate length of signal and power interconnecting cable.

E. Flow Stream to be Measured: See schedule.

F. Analog Output:
1. Guaranteed overall mA output accuracy when configured with six diameters of straight pipe upstream of the electrode axis and two diameters of straight pipe downstream of the electrode axis, at ideal temperature, input voltage, and load:
   a. Range: 1000 to 1 on 6" and smaller, 1500 to 1 on 8" and larger.
   b. Accuracy: 1/2" to 6" 0.2% of rate; 8" and larger 0.15% of rate.
   c. Repeatability: ±0.05% or ±0.0008ft/s, whichever is greater; ±0.5% at 0.67 feet per second (FPS), changing to ±0.2% at 1.64 FPS.
2. Inaccuracy due to ambient temperature changes shall not exceed ±0.025% of flow rate per degree difference from 21°C ambient.
3. Inaccuracy due to changes in load shall not exceed ±0.02% of flow rate from minimum to maximum load.
4. Inaccuracy due to changes in input voltage shall not exceed 0.2% of flow rate at ±10% input voltage and shall not exceed 0.3% of flow rate at 100 input volts.

G. Provide circuitry to eliminate noise errors that would otherwise be caused by hard particles striking the electrodes.

H. Furnish systems with the capability of measuring, indicating, and totalizing flow in both directions.

I. Control Power for Flow Transmitter: 120 VAC, ±10%, 60 Hertz power, at rated accuracy. Power the flow element from the flow transmitter.

J. Ambient Temperature Range Within Which Specified Accuracy is Maintained: -25° to +60° C.

K. Meter Process Pressure Rating:
1. For Flanged Meters: Match the pressure rating of the specified meter flanges.
2. For Wafer Meters: Match the pressure rating of the flanges shown on Drawings.

L. System: Immune to RFI interferences by design or supplied with RFI filters by the meter manufacturer.

2.02 FLOW ELEMENT

A. Comply with the requirements of IP68 for continuous submergence in water and direct burial, as scheduled.

B. Metering Tube: 304 stainless steel.

C. Flanges: Carbon steel ANSI or AWWA, raised-faced, as required to meet the process and piping requirements. Standard connection type to be as follows unless scheduled otherwise:
   1. 1/10" to 4" Wafer design.
   2. 6" to 24" ANSI 150 flanges.
   3. 30" and larger AWWA Class D flanges.

D. Provide one grounding ring or a grounding electrode, with two ground straps with each flow element. Make rings of 304 stainless steel, 316 stainless steel, or of other material as scheduled.

E. Flow Element Liner: PTFE.

F. Electrodes:
   1. Conical and self-cleaning.
   2. Hastelloy C.

G. Coat external surfaces with an epoxy or polyurethane corrosion-resistant coating.

2.03 FLOW TRANSMITTER

A. Features:
   1. Microprocessor based.
   2. Field configurable.
   3. Mounted remotely from the flow element and inside PLC panel if possible.
   4. Multi-function integral LCD display.
   5. A totalizing register for each direction of flow and a total net flow totalizing register, each of which shall be displayed on a time-shared basis on the LCD display, along with the instantaneous flow.
   6. Flow indication and totalizers: Field programmable in engineering units.
   7. Memory retention of totals and programmed configurations during power outages of up to 10 years.
   8. Minimum amplifier input impedance: 10E12Ω.
   9. Enclosure: Coated with an epoxy or polyurethane corrosion-resistant coating, or NEMA 4X.

B. Analog Output:
   1. Isolated, 4 to 20 mA DC signal in linear proportion to flow rate.
   2. Capable of driving loads in the range of 0 to 500Ω without adjustments.
   3. Span and Zero: Field configurable by manual adjustment.

C. Directional Flow Measurement:
   1. Required as standard.
   2. Indicate flow direction on the LCD display.
   3. Provide pulse outputs individually scalable for each direction of flow for totalization at the site and for use by the control system.

4. Provide an output signal to indicate the flow direction. If the output is not a dry contact, then provide a relay in a NEMA 12 enclosure which is controlled by the output signal and connect the relay contact to the process controller. The relay may or may not be shown on the Drawings. Field mount adjacent to transmitter and connect.
5. Provide separate 4-20mA signal for direct and reverse flow. Two 4-20mA output signals required.

D. Low Flow Cutoff:
1. Field configurable from 0 to 10% of flow range.
2. Below the low flow cutoff and during empty pipe conditions, show zero flow on the local display, transmit a 4 mA signal to indicate zero flow, and do not accumulate totalizer counts.

E. Full Scale Range: Adjustable between 1 and 49 FPS.

F. Dampening adjustment to control the rate of change of the transmitter output.

G. Electronics: Self-checking; display error messages.

H. Configuration of Transmitter: Accomplished by means of pushbuttons.

I. Profibus connection and protocol for transmission of data to PLC.

J. Badger Meter ModMAG M2000, no substitute.

2.04 SIGNAL AND POWER INTERCONNECTING CABLE

A. Furnished by the manufacturer of the flowmeter.

B. Both power and signal cables shall be run in one conduit between the flow element and the flow meter unit. Units that require two conduits are not acceptable.

C. Suitable for transmitting all required power and signals from the flow element to the transmitter, up to a maximum distance of 330'.

D. Supply as a single piece for each meter.

E. Terminals, terminal installation tools, cable seals, and seal fittings, as needed to obtain the specified submersible rating: furnished by the factory as part of the system.

2.05 FIELD CALIBRATOR

A. Capable of providing a minimum five-point calibration of the flow transmitters in the field.

B. Furnish a calibrator if scheduled in Specification 26 00 60- Extra Materials and Spares for Electrical Systems.

2.06 FACTORY TESTING

A. Hydraulically calibrate each meter at the factory at a minimum of three calibration points to be determined by the manufacturer for best possible accuracies based on the meter size.

B. Supply each meter with a curve and certificate defining the calibration points used in verifying that the meter meets the required accuracy criteria.

C. Flow facility must be certified by volume or weight certified provers. Facility must have the capability to hold the flow rate at the calibration points for a minimum of 5 minutes to allow stabilization for flow and repeatability point checks. Maximum uncertainty of 0.07% of flow rate.

D. Conduct testing by means of a gravimetric method similar to that used by the NIST. Testing based on a volumetric method will be accepted only from laboratories having a minimum 5-year history of compliance with NIST accuracy standards.

E. Factory/Field Verification:
   1. Test Mode: Provide the ability to verify the accuracy of the unit and the integrity of the current loop without any external equipment.
   2. Self-Diagnostics: Internal checks of all outputs and displays.
   3. *In situ* Calibration Verification: This system shall be able to verify in a quantifiable manner the current condition of the meter versus the condition of the meter when originally manufactured, then factory tested. This calibration verification of the meter shall be performed without need for physical access to the meter flow tube. The calibration verification shall meet or exceed the following requirements:
      a. The original FINGERPRINT values shall be stored on a computer disk given to the Owner.
      b. The verification process shall consist of at least 52-meter conditions pertaining to the primary coils, electrodes, interconnecting cable and signal converter.
      c. The coil verification shall include faults of continuity, impedance, resistance to ground, inductance, and magnetic field strength.
      d. The electrode verification shall include faults of continuity, impedance, and insulation.
      e. The cable verification shall include faults of coil, electrode, driven shield, and ground connections, cable cuts, cable damage, and water in the cable.
      f. Signal converter verification shall include faults of current supply to coils, zero offset, span forward and reverse, electrode offset, current output, frequency output forward and reverse, driven shield to ground, overall shield to ground, and signal ground connection to ground.
      g. The calibration verification shall include the following: Water ingress into the primary elements, faulty electrodes, dirty electrodes, electrode leakage, corroded electrodes, high process noise, liner failure, conductive coatings on the liner, insulating coatings on the liner, and primary element damage.

h. All tests shall be performed by means of comparison between the absolute values and change in values from the new conditions.
i. Verification standard shall be ±1% of wet calibration for meters produced using the calibration verification service, or ±2% for standard meters.
j. The software shall be Windows®-based. This software shall be capable of generating a report based upon the result of the forgoing described tests. The software shall be capable of creating and storing an audit trail of the meters conditions and the meters history.
k. The calibration verification and metering system shall meet or exceed the standards established by the NIST.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount and install in accordance with the manufacturer's instructions.

B. Install all conduits; install power, ground, and load conductors; and install factory furnished interconnecting cable in the conduit.

C. Energize the system only upon request of the manufacturer's field service representative.

3.02 STARTUP SERVICES

A. Furnish the services of a manufacturer's field service representative to accomplish the following:
1. Install cable seals, dress and terminate the cables, and make all final connections at each flow element and transmitter.
2. Certify by letter or copy of the service report that all conductors are properly terminated and connected, and that the installation meets the manufacturer's requirements to achieve the specified submergibility and is in accordance with the manufacturer's installation instructions.

B. Include the cost of these services in the cost of each flowmeter.

3.03 SCHEDULE

Tag	Description	Size	Range	Flow Settings
02-FIT101	Abajo Lift Station #2 Effluent Flow	10"	0-2000 gpm	Normal: 800 gpm Scour: 1000 gpm

END OF SECTION

SECTION 40 72 13.10

ULTRASONIC LEVEL TRANSMITTER (4-WIRE)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ultrasonic level transmitter and element.

1.02 SUBMITTALS

A. Manufacturer’s catalog cuts, descriptive data, technical data, ratings, and dimensions.

1.03 OPERATION AND MAINTENANCE (O&M) DATA

A. Manufacturer’s catalog cuts, descriptive data, technical data, ratings, and dimensions.

B. Manufacturer’s standard O&M Manual.

C. Programming software.

1.04 EXTRA MATERIALS

A. One spare sensing element with 50' of cable in the original carton.

PART 2 PRODUCTS

2.01 ULTRASONIC LEVEL TRANSMITTER

A. Agency general purpose approvals: CE, FM, UL, or CSA.

B. Enclosure:
1. UV resistant ABS.
2. IP65 and NEMA 4X.

C. Ambient temperature: -20°C to +50°C.

D. Control Power: 120 VAC, or as scheduled.

E. Communications: As scheduled

F. Accuracy: 0.25%, Resolution: 0.1%.

G. Output:
   1. Two 4-20mA.
   2. Three dry contact relay outputs (programmable).

H. Measuring Range: 0.3 to 15m (1' to 50').

I. Digital Meter:
   1. 6-digit display of flow rate.
   2. Display GPM, flume/weir height, 4 mA value, 20 mA value.
   3. 8-digit display of totalized accumulative flow.
   4. Meter Accuracy: ± 0.1%.

J. Configuration:
   1. Keypad and display.
   2. PC software with connection via RJ11.

K. Display: 100mm x 40mm (4" x 1.5") multi-field backlit LCD.

L. Siemens SITRANS LT500 MultiRanger/HydroRanger, or Engineer reviewed equivalent.

2.02 ULTRASONIC LEVEL SENSING ELEMENT

A. CENELEC/ATEX or FM recognized for use in Class 1 Division 1 locations.

B. Beam Angle: 6 degrees.

C. Measuring Range: 0.45m-15m (1.5'-50' ft)

D. Ambient Temperature: -40° to +95°C.

E. Siemens Echomax XPS-15F, with proper mounting hardware and enough cable to reach transmitter as shown on the drawings or Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install flange adapter with sensor if it is to be mounted to a flange on top of tank.

B. Install transmitter inside PLC Control Panel as shown on the drawings.

END OF SECTION

SECTION 40 72 76.13

LIQUID LEVEL FLOAT SWITCHES (WEIGHTED)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pump-Down and HIGH-HIGH alarm float switches.

1.02 SUBMITTALS

A. Submit as called out in Section 01 33 23 – Shop Drawings, Product Data, and Samples.

B. Submit manufacturer's literature if any substitution is proposed.

PART 2 PRODUCTS

2.01 FLOAT SWITCH

A. Switch: Mercury Free, Weighted, SPDT, 15A, 120VAC with plastic jacketed cable. Provide cable length as required for the particular application and as shown on the Drawings.

B. Cable: #18-2, SJO W/A.

C. Certification: UL Recognized for use in wastewater.

D. Construction: High impact, corrosion resistant, polypropylene housing for use in wastewater up to 140°F.

E. Float Switch shall be Anchor Scientific Mini-Float, Model S-M NO, 2 Wire, Normally Open, Weighted Float Switch or Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install floats as shown on Drawings and in accordance with manufacturer's recommendations.

B. Float Switches:
1. Set level as scheduled, as shown on Drawings, or as directed by Engineer in field.
2. Conduit sizes for float cables are based on a maximum of 0.38" outside diameter cable. Increase conduit size if required for larger cable.

END OF SECTION

SECTION 40 73 13

PRESSURE GAUGES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install pressure gauges and gauge accessories as specified and as shown on the Drawings.

1.02 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
   1. Product Data for Gauges and Accessories.

1.03 OPERATION AND MAINTENANCE DATA

A. Section 01 78 23: Operation and Maintenance Data.

B. Manufacturer's complete operations and maintenance manuals, including the following items as a minimum:
   1. Operating Instructions.
   2. Maintenance Instructions.
   3. Calibrating Instructions.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES FOR SEWAGE/SLUDGE AND NON-POTABLE WATER SERVICE

A. Accuracy Requirements: ±1.0% of span, ASME B40.100 Grade 1A.

B. Materials of Construction and Design Features:
   1. Bourdon Tube: Type 316 stainless steel.
   2. Case liquid filled at factory, glycerine.
   3. Case: Type 304 stainless steel.
   4. Dial Size: 4".
   5. Process Connection: Type 316L stainless steel, ¼" NPT lower connection on gauge.

C. Scale: As shown on Drawings.

D. Manufacturer: WIKA Type 233.54; ¼" male NPT process connection; factory filled and tack welded to overpressure protector-diaphragm seal assembly to form a single unit. See Drawings for gauge connection mounting and required installation.

E. Overpressure Protector: WIKA Type 910.13.
   1. Function: Spring-actuated piston closes valve at given high pressure setting to protect gauge.
   2. Connections: ½" NPT male inlet, ¼" NPT female outlet.
   3. Body and Piston Valve: Type 316 Ti SS (titanium stabilized).
   4. O-Ring: FPM (Viton).
   5. High Pressure Setting: Factory preset to match high pressure scale value on gauge.

F. Gauge Diaphragm Seal: WIKA Model L990.10 diaphragm type chemical seal with ½" NPT female process connection for non-potable water, ¾" NPT female process connection for sludge service. Refer to gauge assembly details on Drawings.
   1. Overpressure protector (instrument) connection size: ½" NPT female.
   2. Body and Diaphragm: 316L stainless steel.
   3. Gasket: Viton.

PART 3 EXECUTION

3.01 INSTALLATION

A. Per manufacturer's instructions.

3.02 SCHEDULE

A. As indicated on Drawings.

END OF SECTION

SECTION 40 78 10

CONTROL PANEL HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control Panel Hardware: switches, pushbuttons, indicator lights, relays, timers, photoelectric cells, and diodes.

1.02 SYSTEM DESCRIPTION

A. If a component is shown on the Drawings but is not fully identified, and it is reasonable to use one of the components below, then submit as such. If no description is applicable, submit a first class product of a reputable manufacturer.

B. Components of certain equipment are specified under the Specification for that equipment and shall be supplied as required.

1.03 SUBMITTALS

A. Catalog cuts. Duplicate submittals of cuts for different applications are not required.

B. Combine with Submittals for Section 40 61 13 – Control System Docs and Procedures, or Section 40 67 10 – Control Panels.

PART 2 PRODUCTS

2.01 SEALED CONTACT SWITCHES AND PUSHBUTTONS

A. Enclosures, operators, contact blocks, legend plates, engraved nameplates, hardware and accessories: Corrosion resistant.

B. All E-Stop pushbuttons shall be lockout type.

C. Enclosures:
1. Class I, Division 1, Class I, Division 2, and Process Areas: NEMA 4X.
2. Non-Process Indoor Areas: NEMA 12.
3. As shown on Drawings.

D. Operators: NEMA 4X where mounted in NEMA 4X enclosures; NEMA 13 where mounted in NEMA 12 enclosures or control panels.

E. Allen-Bradley Bulletin 800R for 4X application; Bulletin 800T for NEMA 13; or Engineer-approved equivalent.

2.02 LED PILOT LIGHTS

A. High brightness light emitting diode with cartridge holder.

B. Complete with current limiting resistor suitable for DC supply voltage and 400 PRV diode to block reverse voltage.

C. Lighted Pushbuttons or Switches: Not acceptable.

D. Push-to-test type unless specifically shown otherwise on Drawings. Push-to-test wiring may not be shown on schematics.

E. Enclosures:
1. Class I, Division 1 and Class I, Division 2 areas: Copper-free, cast aluminum, NEMA 7.
2. Process areas: NEMA 4X.
3. Non-Process Indoor areas: NEMA 12.
4. As shown on Drawings.

F. Devices:
1. NEMA 7 where mounted in NEMA 7 enclosures.
2. NEMA 4X where mounted in NEMA 4X enclosures.
3. NEMA 12 where mounted in NEMA 12 enclosures.

G. Allen-Bradley Bulletin 800H for 7 or 4X application; Bulletin 800T for NEMA 12 application; or Engineer approved equivalent.

2.03 MINIATURE PLUG-IN RELAY

A. Contacts:
1. SPDT or DPDT as shown on the Drawings.
2. Pilot Duty Rating: NEMA B300.
3. Rated Thermal Current: Single Pole = 10A; Double Pole = 5A.
4. Rated Insulation Voltage: 250V IEC; 300V UL/CSA.
5. Single pole 120 VAC single phase inductive rating: Make 30A; Break 3A; 1/3 HP.
6. Double pole 240 VAC single phase inductive rating: Make 15A; Break 1.5A; 1/2 HP.
7. Make, break, and continuous at 30 VDC: Single Pole = 10A; Double Pole = 5A.

B. Coil:
1. Nominal 60 Hz AC coil voltages available: 6, 12, 24, 120, 240 VAC.
2. Nominal DC coil voltages available: 6, 12, 24, 48, 110 VDC.
3. Permissible coil voltage variation:
   a. 85 to 110% of nominal voltage at 60 Hz.
   b. 80 to 110% of nominal voltage at DC.
4. Maximum AC power consumption: 1.2 VA.
5. Maximum DC power consumption: 0.53W.

C. Dielectric Withstand Voltage: Pole to pole or pole to coil => 1500 VAC RMS.

D. Mechanical Life Operations: Minimum 5 million.

E. Switching Frequency Operations: 1800 per hour.

F. Operating time at nominal voltage at 20°C: Pickup = 15 ms; Dropout = 15 ms.

G. Environmental:
1. Operating Temperature: -30° to +55°C.
2. Altitude: 2,000 meters.

H. Construction:
1. Insulating Material: Molded high dielectric material.
2. Enclosure: Transparent dust cover.
3. Contact Material: Silver-cadmium oxide.

I. Socket:
1. Screw terminal, DIN-mount.

J. Allen Bradley Bulletin 700 HK with HN socket or Engineer reviewed equal.

K. Use for programmable logic controller output interposing relays except where higher contact current ratings are required.

L. If input interposing relays are used, then use either the above relay or Allen-Bradley Bulletin 700-HL Terminal Board Relays.

2.04 HEAVY DUTY RELAY

A. 600V, industrial type.

B. Contacts: Field convertible by inverting plug-in contact module with captive terminal clamp screws.

C. Contact Rating:
1. Minimum: 7200VA make, 720VA break, 10A continuous.
2. Provide 20A contacts where required on the Drawings.

D. Contact Arrangements: As shown on the Drawings.

E. GE Type CR120B or Engineer approved equivalent.

PART 3 EXECUTION

3.01 MOUNTING OF SWITCHES AND PILOT LIGHTS

A. On control panel where so shown on detail or implied by schematic.

B. On wall if sufficiently close to controlled equipment or control point.

C. On Unistrut bolted to floor or bolted to side of pump base.

D. Location subject to approval of Engineer.

E. Support enclosure independent of conduit.

3.02 MARKING

A. Switches, pilot lights, and other components mounted in/on a control panel: Mark as required in Section 40 67 10 – Control Panels.

B. Switches and pilot light not mounted in/on a control panel: Engraved nameplate (NP) on or adjacent to enclosure.

C. Other components, such as relays, timers, time clocks:
   1. Engraved NP on the face of the enclosure.
   2. If more than one such component in an enclosure: Engraved NP inside the enclosure adjacent to each component.

D. Text:
   1. As shown on Drawings.
   2. If not shown on Drawings, use name and tag number of associated process equipment.

END OF SECTION

SECTION 40 78 59.13

DC POWER SUPPLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. DC power supplies.

B. DC uninterruptible power supplies/Buffer Modules.

1.02 SUBMITTALS

A. Make combined submittal as part of a larger assembly, such as a control panel with a programmable logic controller.

B. Manufacturer's literature.

C. Battery literature (if applicable).

D. Complete model number.

PART 2 PRODUCTS

2.01 DC POWER SUPPLIES

A. Safety and Performance Requirements:
1. Listed under UL Standard 508.
2. EMC & Noise Emission Directives EN61000-6-2 and EN50081-2.
3. CE EMC Directive 89/336/EEC.
4. CE LVD Directives 73/23/EEC.
5. MTBF greater than 500,000 hours in accordance with IEC 61709 (SN 29500).

B. Housing: IP20, fully enclosed metal housing.

C. Terminations: Plug connection with no exposed live voltage in accordance with IEC 529.

D. Mounting: 35mm DIN-rail conforming to DIN EN 50022.

E. Input Voltage: 85 to 264 VAC, 47 to 63 Hz.

F. Operating Temperature Range: -25° to +60°C.

G. Output current rating for this project:
1. Calculate worst-case load.
2. Furnish model with 60°C current rating of 1.33 times worst-case load.

H. Typical Efficiency: Power Supplies shall have an efficiency of at least 80% with high efficiency models (~90%) available. Voltage adjustment capability:
   1. Nominal 12 VDC Supply: 12 to 14 VDC.
   2. Nominal 24 VDC Supply: 18 VDC to 29.5 VDC (> 24 V constant capacity. Output Voltage Fluctuation: < ± 2% overall (combination line, load, time and temperature-related changes).

I. Residual ripple shall not exceed 100 mV peak-to-peak at nominal current values. Input over-voltage protection: 105%.

J. Inrush Current: 40A maximum.

K. Termination:
   1. Finger-safe in accordance with IEC 529 (EN 60529: 1991).
   2. Wires shall be attached to the power supplies by means of a cable-clamping terminal block activated by a screw or a bi-stable spring clamp. Connections shall be gas-tight, and the terminal block shall be fabricated of non-ferrous, non-corrosive materials.

L. Dielectric Withstand Strength (Insulation Voltage):
   1. Between input and output terminals: Minimum 3,000 VAC, 1 minute.
   2. Between input terminals and housing: Minimum 2,000 VAC, 1 minute.
   3. Between output terminal and housing: Minimum 500 VDC, 1 minute.

M. Status Indication:
   1. Contact for remote indication of failure if input supply power is lost.
   2. “DC Power OK” LED.

N. Ability to limit DC current in case of short circuit or overload event.

O. Thermal Magnetic Circuit Breakers: When used, breakers shall be of selective fuse-breaking technology.

P. Parallel mode operation without external circuitry.

Q. Warranty: 5 years.

R. Phoenix Contact QUINT Series, (Third Generation with SFB), PULS Dimension QS Series, or Engineer reviewed equivalent.

2.02 DC UNINTERRUPTIBLE POWER SUPPLIES/BUFFER MODULES

A. General:
   1. DC UPS and buffer modules shall be fully enclosed, and provide screw terminations. All wiring points and plug connections shall be "touch safe" with no live voltages that can make contact with a misplaced finger, in accordance with IEC 529.
   2. Housing: IP20 (minimum).

3. Battery backup time period: Selectable using a switch on the front UPS.
4. MTBF: >500,000 hours according to IEC 1709.
5. Vibration Shock: 30 g in all space directions in accordance with IEC 68-2-27 and vibration up to 2.3 g 90 min (<15 Hz, amplitude = ±2.5 mm/15-150 Hz) according to IEC 68-2-6.
6. Efficiency: > 95%.
7. Electronic short circuit protection on DC output.

B. Mounting:
1. 35mm DIN-rail conforming to DIN EN50022.
2. Battery modules: Metal foot attached to 35mm DIN-rail or tabs that allow for a panel mount configuration.

C. Wire Connections:
1. Cable-clamping terminal block activated by a screw.
2. Fabricated with non-ferrous, non-corrosive materials.

D. Status Indication:
1. "DC Power In OK" LED.
2. Dry contact for “Alarm” status indicating backup period expired, battery presence, and battery quality (UPS only).
3. “Battery Mode” LED indicating where operating on batteries (UPS only).
4. “Battery Charge” display to indicate whether the battery is charging or not (UPS only).

E. UPS Equipment:
1. Be of an intelligent design that facilitates communication between the DC UPS and Battery.
2. Automatic battery presence check once every 60 seconds.
3. Automatic battery quality check once every 180 hours.
4. Batteries:
   a. Maintenance-free, valve-regulated lead-acid.
   b. Hot swappable.
   c. Accepts up to five 1.3AH to 38AH batteries wired in parallel and will not require external circuitry.
   d. Individually fused.
5. Temperature-compensated battery charging.
6. Must be able to indicate current charge level of the connected battery module(s).
7. Must be able to indicate the remaining amount of runtime while in battery backup operation.
8. Must be able to indicate the remaining working lifespan of the battery module(s) before replacement.
9. Configurable parameters through PC Software.
10. Capable of providing up to 150% of its rated output current.

F. Warranty: Five (5) years.

G. DC UPS:
   1. Phoenix Contact QUINT-UPS-IQ series, PULS U-Series DC-UPS, or other Engineer reviewed equivalent.

H. Buffer Modules (40A):
   1. Phoenix Contact QUINT Power, model series QUINT-UPS/24DC/24/DC40 amp, P/N 23 20 24 1, or Engineer reviewed equivalent.

PART 3 EXECUTION

3.01 SCHEDULE

A. DC UPS required.

B. Program output of DC UPS to alarm when batteries require replacement.

END OF SECTION

SECTION 40 80 00

PROCESS CONTROL EQUIPMENT COMMISSIONING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commissioning of Process Control System (PCS), including:
   1. Verification of installation and wiring.
   2. Testing of individual devices, subsystems, and systems.
   3. Demonstration of integrated operation.
   4. Documentation of test procedures and results.

1.02 RELATED SECTIONS

A. Section 40 60 10 – Installation, Testing, and Calibration of Instrumentation.

B. Section 40 60 20 – Installation and Testing of Control Circuits and Devices.

C. Section 40 61 13 – Control System Documents and Procedures.

D. Section 40 61 93 – Instrumentation and Control Wiring Schedule and Tag List.

E. Section 40 61 96 – Process Control Descriptions.

F. Section 40 67 10 – Control Panels.

G. Section 40 68 13 – Human Machine Interfaces.

1.03 SUBMITTALS

A. Action Submittals
   1. Preliminary commissioning scheme describing:
      a. Proposed subsystem breakdown.
      b. Sequence of testing.
      c. Roles and responsibilities of Contractor, Integrator, and manufacturers.
   2. Draft test procedures for each subsystem and system, with step-by-step instructions, check-off lines, and spaces for results.

B. Informational Submittals
   1. Commissioning schedule coordinated with project milestones.
   2. Test equipment description, calibration records, and simulation methods.
   3. Certifications from manufacturers' field service representatives confirming readiness for commissioning.

C. Closeout Submittals
   1. Final Commissioning Report:
      a. Assemble completed and signed test procedures.
      b. Organize in order of tag numbers per Section 40 61 93.
      c. Include printed names and signatures of test personnel and witnesses.
      d. Submit in searchable PDF format.
   2. Final updated commissioning scheme reflecting actual testing sequence and methods.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 COMMISSIONING PLAN DEVELOPMENT

A. Meet with Engineer to establish outline for commissioning, including subsystem definitions and test order.

B. Submit draft test procedures and overall scheme for review.

C. Revise documents in response to Engineer's comments.

D. Prepare and issue final approved procedures and commissioning scheme prior to testing.

3.02 PREREQUISITES

A. Conditions:
   1. Do not commence commissioning until:
      a. Installation of all process equipment, piping, electrical power, control, and instrumentation systems is complete.
      b. Manufacturers' certifications of installation and preliminary testing are submitted.
      c. Approved test procedures and commissioning scheme are available on-site.
      d. Commissioning schedule has been coordinated with Owner and Engineer.

B. Preliminary Testing:
   1. Prior to commissioning, complete and submit results for:
      a. Mechanical/process equipment functional testing.
      b. Instrumentation testing and calibration (Section 40 60 10).
      c. Control circuits testing (Section 40 60 20).
      d. Verification of proper HAND (manual) operation for all equipment.
      e. Individual device checks for any remaining untested control equipment.

3.03 TEST EQUIPMENT

A. Provide all test equipment required for commissioning, including simulation devices for process conditions.

B. Maintain calibrated, traceable test instruments for all measurements.

3.04 SYSTEM COMMISSIONING

A. Execution:
1. Perform commissioning in accordance with approved test procedures and scheme.
2. Record results, annotate deviations, and sign off completed steps.
3. Submit completed procedures as part of Final Commissioning Report.

B. Contractor Responsibilities:
1. Provide knowledgeable personnel throughout commissioning to operate, adjust, and repair equipment.
2. Ensure availability of installation staff without interrupting test execution.

C. PCS Integrator Responsibilities:
1. Provide Field Service Representative(s) for PLCs, OIUs, OITs, and control panels.
2. Test all control system hardware and software, including:
   a. PLC and I/O functionality.
   b. OIU/OIT graphics and operator functions.
   c. Network and communication protocols.
3. Demonstrate integrated system operation to Owner and Engineer.

D. Manufacturer Responsibilities:
1. Provide Field Service Representative(s) for specialized equipment as required by respective Sections.
2. Participate in functional verification and troubleshooting.

E. Demonstrations:
1. After completion of subsystem and system testing, schedule final demonstration with Owner and Engineer.
2. Demonstrate full system operation under simulated or actual process conditions.

END OF SECTION

SECTION 41 22 00

HOISTS AND CRANES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install various types of lifting equipment including hoists, trolleys, jib cranes, bridge cranes, runway beams, monorail beams, hangers, and sockets at locations shown on Drawings.

B. Furnish and install miscellaneous components and accessories for electrification of hoist and crane components where indicated on Drawings.

1.02 RELATED SECTIONS

A. Section 05 50 01 – Anchor Bolts and Chemical Anchors.

1.03 QUALITY ASSURANCE

A. Acceptable Manufacturers:
1. R&M Materials Handling, Inc.
2. Hoist and Crane Div. of Robbins and Myers, Inc.
3. Chissom Moore, CM Hoist Div. of Columbus McKinnon Corp “CM.”
4. ACCO Industries Inc., Hoist and Crane Division.
5. Thern, Inc.
6. Spanco, Inc.
7. Chester Hoist.
8. Gorbel.
9. Yale.
10. Or Engineer reviewed equivalent.

B. Erector Qualifications:
1. Licensed New Mexico Contractor with appropriate classification to work on overhead crane and hoist systems.
2. Regularly engaged in hoist and crane erecting.
3. Acceptable to manufacturer.

C. Requirements of Regulatory Agencies:
1. OSHA Standards, Subpart N – Materials Handling and Storage, 29 CFR 1910.179 – Overhead and Gantry Cranes.
2. Obtain all necessary inspections and certifications.

D. Reference Standards:
1. ANSI B30.11: Monorail Systems and Underhung Cranes.
2. ANSI B30.17: Overhead and Gantry Cranes (Top Running Bridge, Single

Girder, Underhung Hoist).
3. ANSI B30.2.0: Safety Code for Overhead and Gantry Cranes.
4. ANSI MH27.1: Patented Track Underhung Cranes and Monorail Systems – Specifications.
5. CMAA (Crane Manufacturers Association of America, Affiliate of Material Handling Industry of America). Specification #74 – Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist.
6. CMAA Specification #100 – Electric Wire Rope Hoists.

E. Standardization: All hoists, trolley, jib cranes, and bridge cranes supplied by a single supplier unless otherwise specifically approved in writing by Engineer.

F. Warranty For Materials and Workmanship:
1. Manual Systems: ten (10) years.
2. Paint and Finishes: two (2) years.
3. Motorized Systems and Equipment: one (1) year from date of Substantial Completion.

1.04 SUBMITTALS

A. Product Data: Section 01 33 23 – Shop Drawings, Product Data, and Samples.
1. Sufficient data to verify compliance with specifications.
2. Outline and installation drawings.
3. Data describing materials used, parts, devices, rails, stops, and other accessories.
4. Installation instructions including anchor bolt requirements and pattern.
5. Schematic wiring diagrams.
6. Warranty.

B. Copies of all required inspection reports, certificates, and load test reports.

C. Operation and Maintenance Manuals: Section 01 78 23 – Operation and Maintenance Data.

1.05 TRAINING FOR OWNER'S PERSONNEL: Section 01 79 01 – Manufacturer's Instruction of Owner's Personnel.

1.06 COORDINATION

A. Coordinate with the work of other trades who are furnishing structural supports for bridge crane support rails and/or monorails.

PART 2 PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Schedule.

2.02 MATERIALS

A. Bridge Crane Truck and Trolley Wheels: Forged steel or cast iron with hardened tread.

B. Axles: Steel.

C. Gearing:
1. General: Steel or cast iron.
2. Pinions: Heat treated alloy steel.

D. Bearings: Antifriction, oil lubricated or permanently grease-packed.

E. Cable: Improved plow steel.

F. Lifting Hook: Forged steel with safety latch.

G. Chain:
1. Load Chain: Zinc plated carbon steel.
2. Hand Chain: Aluminum.

2.03 FABRICATION AND MANUFACTURE

A. General: Comply with MMA standards and HMI No. 100 except as specified herein.

B. Trolley:
1. Hand operated with chain unless otherwise scheduled.
2. Geared type.
3. Capacity: See schedule.
4. Factory labeled per OSHA requirements.

C. Hoists:
1. Hand Operated Chain Hoists:
   a. 85 lb. maximum pull.
   b. Lifting chain: nickel-plated carbon steel.
2. Electric Operated Hoists:
   a. Controls and electrification as scheduled.
   b. Wire rope cable or link chain as scheduled.
   c. Automatic load brake to hold load at any point.
3. Lifting height: See schedule.
4. Capacity: See schedule.
5. Low head type unless otherwise scheduled.
6. Factory labeled per OSHA requirements.
7. All chain hoists furnished with bucket for storing chain.

D. Jib Cranes:
1. Mast support and anchorage as indicated on Drawings.
2. Capacity and other requirements: See schedule.

3. Factory labeled per OSHA requirements.
4. Free standing base mounted unless otherwise scheduled.
5. Upper roller assembly radial and thrust bearings: Re-greasable self-aligning tapered roller bearings.

E. Bumpers and Stops: As indicated on Drawings and/or as required to provide a complete, safe, ready to use system.

F. Rails and Girders: Monorails, jib crane hoist rails, bridge crane runway rail beams, and bridge crane main girder are to be nominal dimensions shown on Drawings unless otherwise reviewed by Engineer; proper rail sizing is responsibility of hoist manufacturer. Install rails in accordance with CMAA specifications.

PART 3 EXECUTION

3.01 ERECTION

A. Erect in accordance with manufacturer's instructions.

B. Complete ready to use installation.

3.02 TESTING

A. Perform initial operational testing in accordance with OSHA standards.

B. Perform load test at 125 percent of rated load of equipment in conformance with OSHA 1910.179.

3.03 FIELD SERVICE REPRESENTATIVE

A. Start-up, check, and perform load test, adjust systems and components.
1. Two hour on-site minimum.

B. Certify in writing that the systems are properly installed and ready for use.

C. Train Owner's Personnel:
1. Two hours minimum, devoted exclusively to training.
2. Schedule in writing with Engineer.

3.04 SCHEDULE

A. Freestanding jib crane, motorized trolley, and hoist located at new Abajo Lift Station:
1. Service: Outdoors.
2. Capacity: One ton.
3. Span: Minimum 15 feet.
4. Clearance from beam to ground: As indicated on Drawings.
5. Construction: Fabricated from ASTM A36 steel sections with finished ends and surfaces.

6. Factory Coating:
7. a. Surface Preparation: Deburred and descaled using power tools followed by high-pressure washing and degreasing.
   b. Coating: Yellow semi-gloss industrial enamel, 2 to 3 mils DFT.
8. Mounting: Base-Plate mounted to a permanent concrete foundation. Base plate with knee braces furnished by Manufacturer.
9. Head Assembly: Designed to transfer boom load to mast and allow for rotation using trunnion rollers.
10. Hoist: Link Chain.
11. Electrification: Two speed hoist and trolley and jib boom rotation. 3 HP, 460 VAC, 3-phase.
12. Controls: Pendant push button station.
13. Tagline Festoon System for attaching electrical cable to boom.
14. Warranty.

END OF SECTION

SECTION 43 25 13

SUBMERSIBLE SEWAGE PUMPS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Submersible pumps and related accessories for lift stations and other uses as scheduled at the end of this Section.

B. The facilities have been designed to accommodate Flygt pumps as the design basis. All changes or alterations to facilities which are needed to accommodate another pump manufacturer shall be included as work under this specification.

1.02 RELATED WORK

A. Section 26 29 23 – Variable Frequency Drives.

B. Section 41 22 00 – Hoists and Cranes.

1.03 REFERENCES

A. Hydraulic Institute Standards.

B. National Electric Code Standards.

1.04 SUBMITTALS

A. Section 01 33 23 – Shop Drawings, Product Data, and Samples:
1. Product data.
2. Performance curves, pump and motor.
3. Materials of construction.
4. Dimensioned pump outline drawings and weights.
5. Lift station drawing for accessories.
6. Motor drive data.
7. Electrical control and power diagrams.
8. Access cover drawing.
9. Warranty.
10. Installation instructions.

B. Section 01 78 23 – Operation and Maintenance Data.

C. Section 01 79 01 – Manufacturer's Instruction of Owner's Personnel.

D. Certification that Installation is Ready to Use: Part 3 herein.

1.05 QUALITY ASSURANCE

A. Factory Tests: The pump manufacturer shall perform the following inspections and tests on each pump before shipment:
   1. An insulation test of the windings,
   2. A test of the pump motor (run dry for 5 minutes at full load) to check electrical data measurements,
   3. A submerged test of the pump to establish correct rotation and mechanical integrity,
   4. A motor and cable insulation test for moisture content and insulation defects, and,
   5. A check of impeller, motor rating, and electrical connections for compliance with purchase order.

B. Manufacturer shall have a local representative located within 200 miles of the job site, who shall have been appointed by the manufacturer three (3) years prior to bid date, who maintains a factory-authorized service/repair facility staffed with factory-trained mechanics, stocked with a minimum of $100,000 inventory of manufacturer's repair parts and supported with service trucks, fitted with lifting cranes for job site service.

1.06 WARRANTIES

A. In printed form, and apply to all similar units.

B. The manufacturer shall provide a written warranty as standard covering workmanship and defects in materials for a period of five (5) years from date of Substantial Completion. The warranty shall cover parts, labor, and return freight as follows: 1-18 months – 100%; 19-39 months – 50%; 40-60 months – 25%.

C. The warranty does not excuse the Owner from performing scheduled routine preventative maintenance. The Owner shall be required to maintain scheduled service maintenance records for all warranted equipment. The manufacturer shall repair or replace, at its discretion, any warranted equipment that fails within the warranty period. The manufacturer shall not be responsible for equipment damage resulting from misuse, abuse, improper installation or storage, failure to perform or schedule routine preventative maintenance, defective power supply, improper electrical protection, tampering, or the like. The warranty does not include the cost for normal wear and maintenance items and/or parts.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Flygt.

B. Or Engineer reviewed equivalent.

C. All pumps specified in this Section by same manufacturer.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Schedule.

2.03 PUMP MATERIALS

A. Volute, Impeller, Motor Housing, Discharge Elbow, and Other: Gray cast iron ASTM A-48, Class 35 B, with smooth surfaces devoid of blow holes or other casting irregularities.

B. Shaft:
1. Mid range pumps (12 – 160 hp), ASTM A479 S43100-T stainless steel.
2. Small range pumps (up to 11 hp), ANSI 431 stainless steel.
3. Stainless steel sleeves covering shafting constructed of lesser materials are not acceptable.

C. Motor:
1. Rotor Bars and Short Circuit Rings: Aluminum.
2. Stator Winding and Lead Insulation: Class H monomer-free polyester resin.

D. Mechanical Seal: Tandem seals with all seal farces to be abrasion and corrosion resistant solid sintered tungsten carbide featuring a nickel binder to cement tungsten-carbide particles together during sintering.

E. N Impeller and Volute Insert
1. Standard N impeller: ASTM A48, Class 35B gray iron, with leading edges of the gray iron impeller hardened to Rc 45.
2. Hard Iron N impeller (if listed in schedule): ASTM A532 25% chrome cast iron, Alloy IIIA, with the leading edges of the impeller hardened to Rc 60.

F. C impeller: ASTM A48, gray cast iron, Class 35B.

G. Wear Rings: Required if C-impeller scheduled.
1. Case Wear Ring: Nitrile rubber molded with steel ring insert.
2. Impeller Wear Ring on 20 Horsepower or Larger Pumps: ANSI 304 SS.

H. Exposed Nuts and Bolts: Type 304 stainless steel.

I. Guide Bars and Guide Bar Brackets: Type 304 stainless steel.

2.04 PUMP CONSTRUCTION

A. Water Tight Sealings: Nitrile rubber O-rings against machined surfaces.

B. Cable Entry Design:
1. Junction chamber to be sealed from motor by a non-hydroscopic, feed through type terminal board and elastomer compression seal.
2. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal.
3. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter.
4. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function.
5. The assembly shall provide ease of changing the cable when necessary using the same entry seal.
6. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.
7. Epoxies, silicones, or other secondary sealing systems will not be considered equal.
8. Epoxies, silicones, or other secondary sealing systems will not be considered equal.
9. Junction chamber to be sealed from motor by a non-hydroscopic, feed through type terminal board and elastomer compression seal.

C. Pump Motor:
1. Air filled, NEMA B design, squirrel cage induction type, housed in air-filled watertight chamber.
   a. Stator to be insulated by trickle impregnation to achieve a minimum 95% winding fill factor using monomer free polyester Class H resin rated for 180-deg C (356-deg F) with winding fill factor of at least 95%, and heat shrink fitted into the stator housing (designs requiring penetration of stator housing are not allowed).
2. Sensors:
   a. Pumps 3 to 10 HP: Equipped with winding over-temperature switch in each phase. Set to open at a maximum of 140ºC.
   b. Pumps 12 to 105 HP: Equipped with winding thermal sensors and a float switch in the motor housing to detect presence of moisture or oil. Also furnish a control and status monitor (miniCAS) located in the control panel and wired to the pump to monitor the sensors and stop the motor when called.
3. Combined service factor of 1.15 and rated for operation at 40ºC AMB.
4. Pump Motor: Connections between cable conductors and stator leads to be made with threaded compression type binding posts permanently affixed to terminal board. Connections via wire nuts or crimping devices are not allowed by this Specification.
5. Inverter duty rated in accordance with NEMA MG1, Part 31.
6. Voltage tolerance of plus or minus 10%.
7. Designed for continuous duty while handling pumped media of up to 104°F.
8. The motor and the pump shall be produced by the same manufacturer.

9. Designed for continuous operation in up to a 40ºC ambient and shall have a NEMA Class B maximum operating temperature rise of 80ºC.
10. Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out.
11. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

D. Motor Cooling System:
1. For pumps up to 10.5 HP: Provide thermal radiators integrally cast into stator housing.
2. For pumps larger than 10.5 HP: Provide cooling jacket to allow circulation of pumped media or propylene glycol around motor housing.

E. Pump Shaft:
1. Rotates in two permanently lubricated ball bearings for pump sizes up to 100HP and three bearings above 100HP.
   a. Upper bearing to be single row deep groove ball bearing up to 100HP and roller type above 100HP.
   b. Lower bearing to be a two-row angular contact ball bearing up to 100HP and one roller and one angular contact roller bearing above 100HP.
2. Completely isolated from pumped liquid.
3. Lower bearing shall contain a temperature sensor for monitoring on units larger than 100HP.

F. Minimum ABMA L10 Bearing Life: 50,000 hours at any point on head-capacity curve.

G. Mechanical Seals:
1. Tandem, independent, run in an oil reservoir using FDA approved, non-toxic paraffin oil or glycol solution and capable of operation in either direction of rotation.
2. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber.

H. Impeller – As Scheduled:
1. N-impeller: Dynamically balanced, semi-open, multi-vane, back-swept, non-clog with vanes of screw shaped leading edges, RC60 hardness, self-cleaning by shearing action from grooves in the volute.
2. C-impeller: Double shrouded, non clogging design with long throughlets without acute turns.
3. Coating: Alkyd resin primer.

I. Volute – As Scheduled:
   1. N-impeller: Volute bottom designed to be of sharp, spiral shaped grooves integrally cast into the suction side of the volute to provide shearing action from the movement of the leading edges of the impeller vanes. Clearance shall be adjustable for wear.
   2. C-impeller: Volute to be of non-concentric design with smooth passageways large enough to pass any solids entering the impeller.

J. Each pump equipped with submersible pump cable:
   1. Pump cable sized according to NEC and ICEA Standards.
   2. Pump cable shall have at least 3 power leads, a ground lead, and two shielded sensor leads.
   3. Pump cable to have oil-resistant, chloroprene rubber jacket.

K. Sliding guide bar bracket to be integral part of pump unit to guide on at least two rails. No portion of the pump or guidance system shall bear on sump floor.

L. Discharge pump/elbow connection seal to be metal to metal. Diaphragm or O-ring type seals are not acceptable.

2.05 PERFORMANCE

A. Pump Motor:
   1. Non-overloading throughout pump curve.
   2. Capable of thirty evenly spaced starts per hour.
   3. Capable of running dry indefinitely without damage.
   4. Capable of continuous operation unsubmerged.
   5. Motors for use in NEC/500/501, hazardous areas: FM, UL or CSA listed for use in the area specified.

2.06 PROTECTIVE COATING

A. Pump Exterior: Acrylic dispersion zinc phosphate primer with polyester resin paint finish.

B. Impeller: Acrylic dispersion zinc phosphate primer.

2.07 ACCESSORIES

A. Furnish the following accessories associated with pump installation. These accessories shall be furnished by the pump manufacturer:
   1. Type 304 stainless steel Schedule 40 guide bars (rails), furnished by pump supplier unless noted otherwise in Schedule or on Drawings.
   2. Type 304 stainless steel upper and intermediate guide bar brackets.
   3. Type 304 stainless steel safety chain hook.
   4. Type 304 stainless steel cable holder/cable hanger rack.
   5. Type 304 stainless steel cable support grips for motor cables and float cables.
   6. Type 304 stainless steel anchorage.

7. Grip eye lifting system.
8. Wet well access cover, if specified in Schedule.
9. Valve vault access cover, if specified in Schedule.
10. Pump hoist and support mount, if specified in Schedule.
11. Mix – Flush system, if specified in Schedule. System shall consist of a hydraulically operated flush valve, factory installed in the vault, and be designed to re-suspend solids and grease in the wet well when the pump turns on. Furnish dash pot to field adjust valve closing time from 20 to 50 seconds.

B. Wet Well Access Cover:
1. Materials: Structural aluminum cover and frame, unless otherwise scheduled.
2. Hardware:
   a. Stainless Steel.
   b. Recessed padlock hasp.
   c. Recessed aluminum lift handle.
   d. Hold-open arm, lock open in 90-degree position.
   e. Stainless steel lift assist for heavy doors so one person can easily open door.
3. Units capable of side-by-side installation using cleats.
4. Nut rail incorporated in frame.
5. 300 pounds per square foot rated, unless otherwise scheduled.
6. Size: Actual clear opening as recommended by pump manufacturer for the pumps being installed in wet well or as shown on Drawings.
7. Hinged grated safety hatch located below doors.
8. Acceptable manufacturers:
   a. Flygt Safe-Hatch.
   b. Flygt.
   c. USF Fabrication, Inc, Hialeah, FL.
   d. Halliday Products, Orlando, FL.
   e. Or Engineer reviewed equivalent.

C. Valve Vault Access Cover:
1. Materials: Structural aluminum cover and frame, unless otherwise scheduled.
2. Hardware:
   a. Stainless Steel.
   b. Recessed padlock hasp.
   c. Recessed aluminum lift handle.
   d. Hold-open arm, look open in 90 degree position.
   e. Stainless steel lift assist for heavy doors so one person can easily open.
3. Units capable of side-by-side installation using cleats.
4. 300 pounds per square foot rated, unless otherwise scheduled.
5. Size: Actual clear opening as recommended by pump manufacturer for the pumps being installed in wet well or as shown on Drawings.
6. Hinged grated safety hatch located below doors.
7. Acceptable manufacturers:
   a. Flygt Safe-Hatch.
   b. Flygt.

c. USF Fabrication, Inc, Hialeah, FL.
d. Halliday Products, Orlando, FL.
e. Or Engineer reviewed equivalent.

D. Grip Eye Lifting System: Furnish each submersible pump with one complete lift-chain positive recovery system consisting of the following components:
1. Chain Sling: Short section of stainless steel chain (length as required by manufacturer) of high tensile strength, proof tested; attached to pump lifting handle on lower end and to cable sling on upper end. Stainless steel chain appropriately sized for weight of pump to be lifted.
2. Cable Sling: Continuous stainless steel cable (length as required) attached to end of chain sling at lower end with stainless steel clamp and attached to safety hook fastened to frame under access cover. A small chain (stainless steel) with threaded link repair rings may be used in lieu of stainless steel cable. A nylon line for the sling will not be accepted.
3. Furnish one complete lift-chain positive recovery system compatible with each jib crane serving submersible pumps or mixers specified in Specification Section 41 22 00 – Hoists and Cranes, consisting of the following components:
a. A forged "grip eye" of wrought alloy steel, provided separately to connect to the end of the lifting cable of the pump or mixer lift hoist.
b. Stainless steel lift cable of sufficient length to reach from jib crane winch to pump in lowest position.
c. Lower Cable Attachment: Stainless steel hoist hook attached to "grip eye."
d. Upper Cable Attachment: Stainless steel swaged ball designed to connect to crane drum.
e. Acceptable manufacturer: Flygt Grip-Eye System or Engineer reviewed equivalent.
4. A stainless steel shackle as part of the chain sling for connecting to the pump or mixer handle.
5. Acceptable manufacturer: Flygt Grip-Eye System or Engineer reviewed equivalent.

2.08 CONTROLS

A. Provide all necessary instrumentation, controls, control panel, and associated equipment as specified and scheduled herein, and shown on the Drawings.

B. Comply with all requirements of Divisions 26 and 40.

C. Control Panel Security Enclosure:
1. Where specified in Schedule, provide a control panel security enclosure for each control panel.
2. Security enclosures designed to prevent unauthorized personnel from accessing panel controls. Provide solid front panel doors.
3. All Type 304 stainless steel construction, conforming to NEMA 4X requirements with stainless steel hardware, hinged access door, and padlock.

PART 3 EXECUTION

3.01 INSTALLATION

A. Manufacturer's recommendations.

B. Level, plumb, accurate alignment, leak-proof pump connection, easily removed without entering wet well as appropriate.

C. No splices allowed in cable.

3.02 FLOATS

A. Suspend on brackets as shown on the Drawings.

B. No splices allowed in cables.

C. Set to levels shown on the Drawings.

D. Provide 12-inches of cable slack for future adjustments.

3.03 REQUIRED SUPPORT BY FIELD SERVICE REPRESENTATIVE

A. See Section 01 75 01 – Field Service Representative, for qualifications of Field Service Representative.

B. Present to check installation and operation.

C. Provide 4 hours of training to Owner's personnel on operation and maintenance per requirements of Section 01 79 01. Video record training sessions in accordance with Section 01 79 01: Manufacturer's Instruction of Owner's Personnel.

D. Furnish written report to Engineer certifying that equipment is properly installed, fully functional, ready for use, and is operating correctly.

3.04 SCHEDULE

A. Project Site Conditions:
1. Site Elevation: 6,275 feet above mean sea level.
2. NFPA 820 Area Classification: Unclassified.

B. New Abajo Lift Station Pumps:
1. Acceptable Manufacturers:
   a. Flygt Model NP 3202 HT3, Hard-Iron™ Impeller and Volute Insert.
   b. Or Engineer reviewed equivalent.
2. Design Operating Point: 1300 gpm at 79.4 ft TDH.
3. Shutoff Head: 141 ft.
4. Maximum Motor kW Input at Design Operating Point: 25.7 kW.
5. Minimum Hydraulic Efficiency at Design Operating Point: 75.6%.

6. Motor: 45 HP, 460V, 3-phase, premium efficiency, FM-explosion proof rated.
7. Drive: Direct.
8. Discharge Size: 6".
9. Mix – Flush System: One Pump.
10. Wet Well Access Cover: As indicated on Drawings with safety grate.
11. Valve Vault Access Cover: As indicated on Drawings with safety grate.
12. Pump Control Panel: Per Divisions 26 and 40 and Electrical Drawings.
13. Junction box to be installed between control panel and wet well, NEMA 4X 304 SS.
14. Level controls and level switch floats: Submersible level transducer with backup level switch floats, as shown on Drawings.
15. Quantity: Two (2) pump assemblies (1 duty, 1 standby).

END OF SECTION